

# S40/S50 MANUAL

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**ARMOUR**<sup>TM</sup>

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### Statement for This Manual

Any user to use the S40/S50 flight control and navigation system is deemed to have accepted this statement.

The user is kindly requested to read this manual carefully before using S40/S50 flight control and navigation system. For any doubt over the system, please contact us for technical support.

To better use this equipment and ensure your safety, please carefully read the instruction book before usage and timely consult the producer for any question.

### Guidance on Usage of the Manual

Common symbols:



**Tips:** The explanation of a problem or phenomenon, or a link leading to other contents related to it.



**Skills:** A technique to simplify or quicken certain operation.



**Prohibited:** Forbidden operation or situation which may otherwise cause permanent damage of the equipment or other severe consequences.



**Caution:** Some problems or phenomena which need particular attention.

# S40/S50 flight control & navigation system



## 1. System Introduction

### 1.1 System overview

S40/S50 is a flight control and navigation system specially designed for hybrid UAVs (vertical takeoff and landing fixed wing) and is applicable to an aircraft with the conventional layout fixed wing + quadrotor configuration.

It internally integrates the flight control computer and micro-assembly navigation system (GPS/INS). It is, with one-key action, capable of enabling automatic takeoff, landing, hovering, circling, homing, altitude setting, parachute opening and various autonomous cruising functions based on the preset route.

Besides, S40/S50 provides the comprehensive flight status monitoring alarm functions and perfect emergency protection mechanism, to ensure the safe operation of the system.

### 1.2 Scope of application

Hybrid UAV with fixed-wing + quadrotor configuration, including the fixed wing aircraft supporting conventional tail and V-tail and flying wing and the quadrotor aircraft supporting "X" configuration.

Conventional fixed-wing (plane) UAV, supports conventional tail, V-tail and flying wing.

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## 1.3 System characteristics

### Sensor configuration

- Integrating micro-system of GPS/MINS combined navigation, it provides comprehensive navigation information covering 3D position, three-axis attitude, three-axis velocity and three-axis acceleration, etc.
- The S50 internally integrates three redundant inertial devices. The main redundancy is ADI gyros and accelerometers of high-quality, which can switch standby margins in real-time according to operating conditions. It has the dual advantages of high measurement accuracy and high reliability.
- Supporting external differential GPS, and is mutually redundant with the internal single point positioning GPS module, and the system automatically selects GPS data with good positioning status.
- Supporting an external compass, for the convenience of the user to select areas with less magnetic interference, as well as improving the accuracy of heading measurement.
- Integrated barometric altimeter, with a resolution of 0.1m and range of -500~10000m.
- Integrated differential pressure air speedometer, with a resolution of 1m/s and range of 0~100m/s.
- 2-circuit pulse-width engine speed measurement, with resolution ratio of 1rpm.
- Dedicated voltage/current measurement module, with a voltage range of 0~52V and current range of 0~200A.

# S40/S50 flight control & navigation system

## Flight control

- It supports three types of UAVs: fixed-wing(plane), multi-rotator and hybrid(vertical takeoff and landing) UAVs.
- For control of hybrid UAVs, the flight mode can be switched by the RC remote controllers or automatically.
- Flight control modes: manual (by the RC remote controller), semi-auto (attitude and throttle lever are controlled by the RC remote controller) and full-auto (flight in the preset route).
- It is suited for aileron, elevator, rudder, throttle, parachute opening, shutter and other servo control, with refresh frequency of 50Hz.
- It is suited for quadrotor and other conventional multi-rotor UAVs power motor control, with a refresh frequency of 200Hz.
- With one-key action, it can enable takeoff, landing, hovering, circling, altitude setting, parachute opening and other functions, for easy operation of the user.
- When a fixed-wing swerves, the elevator enables feed-forward compensation, to avoid altitude decrease.
- When a multi-rotor UAV hovers, it automatically maintains its nose heading (or the course angle can be changed remotely); during flying in a route, the aircraft nose is automatically aligned with the route direction.
- Sophisticated flight status monitoring and automatic flight protection.
- It is suited for automatic ignition after oil engine take-off.

# S40/S50 flight control & navigation system

## Mission navigation

- It provides 8 user routes, with each route can contain 800 waypoints.
- Automatic switching to mission route after take-off is optional.
- It can automatically generate the circling route and the circling point, circling radius and circling rounds are programmable.
- It can automatically generate the homing route, or the user may plot the homing route and homing is automatically executed in the route plotted by users.
- The longitude, latitude, altitude, speed and mission are of flight segment programmable.
- For altitude control modes of the flight segment, normal control, gradient control, circling ascension/descension before arrival and circling ascension/descension after arrival, etc. can be selected.
- Automatic switch to circling, homing, or landing can be set after the aircraft arrives at the waypoint of the route.
- It can enable parachute opening and camera shutter control upon arrival at a waypoint.
- It can execute a regular-interval photographing mission during a flight segment.

## Protection configuration

- Protection against low voltage, low oil level and low rotation speed.
- Protection against abnormal attitude.
- Protection against abnormal altitude.
- Protection against low accuracy of GPS positioning.
- Protection against failure of the combined navigation system.
- Protection against breach of maximum control radius.
- Protection against breach of safety limit of the route.
- Protection against overtime communication outage.
- 100 emergency landing points can be preset so that the aircraft can land at the nearest landing point in case of an emergency.
- Protection measures include automatic return, automatic landing, parachute opening.

# S40/S50 flight control & navigation system

## Remote Control

- It is compatible with the conventional Sbus interfaced RC remote controller and the receiver.
- The manual/autonomous modes can be switched by the RC remote controller.
- The fixed-wing and multi-rotor modes can be switched by the RC remote controller.
- The Fail/Safe status of the RC remote controller is under monitoring.
- The RC remote controller can be used for registration of the servo surfaces.
- The RC remote controller can execute unlocking, to prevent malfunction of the motor.

## Airborne data record

- Flight information and mission information are recorded and downloaded separately.
- The recording frequency and downloading frequency are selectable in the range of 1Hz~10Hz.
- Flight information recording time can be 9 hours.
- 7000 mission information logs can be recorded (on photographing locations).

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## Ground station software

- Supporting multi-source online electronic map with error compensation, as well as MAX and background pictures.
- Complete and practical preflight inspection process prompt.
- Automatic mapping waypoint editing function in the irregular multi-monitoring area.
- Legible and intuitional flight instruments.
- Easy execution of key commands and protection against disoperation.
- Adjustment of integrated control parameters, calibration of sensors, protection of configuration, etc.
- Display, alerting, recording and playback of telemetry data; the formats of the log files are compatible with Office.
- The ground station software is capable of fine adjustment of the horizontal position, altitude and fine-tuning course of multi-rotor UAV, without remote control of the RC remote controller.
- It can generate landing route with one-touch action, enabling the aircraft to automatically circle and reduce altitude at the upload waypoints/current position point, straight return, decrease airspeed and home landing.

## Data link interface

- Electrical standard: RS-232C
- Baud rate: multiple optional Baud rates, default 115200, N, 8, 1

## Physical parameter

- Dimensions: 109mm\*56mm\*53mm (L\*W\*H)
- Weight: 130g
- Power supply: 300mA@4.5~9.0VDC

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## 2 Installation and Connection

### 2.1 Installation



Fig.2.1a Material object of S40



Fig.2.1b Material object of S50

## S40/S50 flight control & navigation system

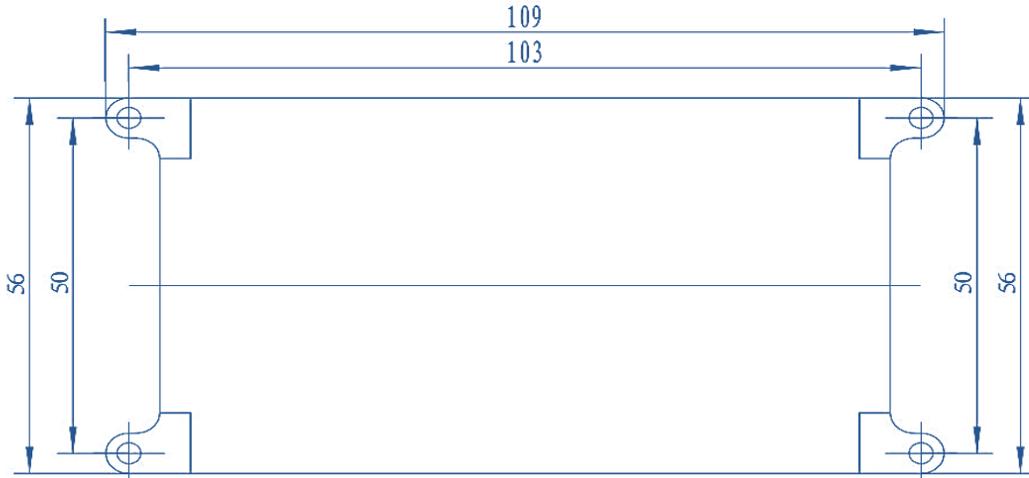


Fig.2.2 Installation dimension of S40 /S50

The material object of S40/S50 system is shown in Fig.2.1 has four  $\Phi 3.2\text{mm}$  mounting holes and the hole distance is  $103\text{mm} \times 50\text{mm}$ .

As shown in Figure 2.2, the user can fix S40/S50 directly by using these mounting holes.

Usually, a dedicated shock absorber is needed between the mounting holes and the device, through which, S40/S50 system is connected to the aircraft body.

Installation direction: The end with an external interface faces the tail.

- ⚠ Note:** S40/S50 should be installed at a position inside the aircraft that is close to the centre of gravity and has minimum vibration and stable temperature; it also needs a dedicated shock absorber (particularly for an oil-fueled UAV), without which the sensor accuracy will be downgraded or even diverged, gravely jeopardizing flight safety.
- ⚠ Note:** installation of S40/S50 must take account into the effect of the other onboard magnetic elements (motor, high-current conductor, etc.) on magnetic heading measurement, and the installation position must be maximally far away from such elements. After installation, the magnetic heading must be calibrated to be maximally close to the actual course; the greater the magnetic heading error, the poorer the horizontal position control accuracy; any magnetic heading error greater than  $20^\circ$  will damage flight safety.
- ⚠ Note:** the installation position of S40/S50 should guarantee that the airflow remains relatively steady during flight, for air turbulence will interfere with internal air pressure measurement and jeopardize flight safety.

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## 2.2. Interface

External interface of S40/S50 aerial plug version is Model J30J-37ZK socket. Interface layout is shown in Fig. 2.3 and interface definition is given in Table 2.1.

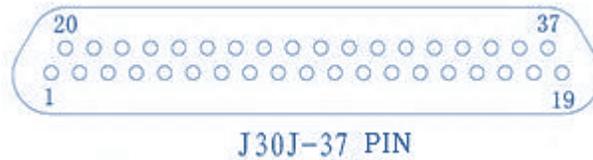


Fig.2.3 Interface layout of S40/S50 aerial version

**Table 2.1 Definition of external interfaces of S40/S50 aerial plug version**

Pin No.	Definition	Description	Remarks	Label
1	PGND	Power ground	Reference ground which can be used as analog input.	
2	ADC1	Analog quantity input 1	When S40/S50 is configured as voltage + current measurement, connected to the external dedicated voltage/current measurement module to monitor the current, with the input range of 0~5.24V (current: 0-200A). When S40/S50 is configured as 2-circuit voltage measurement, used for fixed-wing power battery voltage monitoring (via dedicated 2-circuit voltage measuring line), compatible with 12s lithium battery.	
21	ADC2	Analog quantity input 2	Multi-rotor power battery voltage measurement, connected to external dedicated voltage/current measurement module/dedicated 2-circuit voltage measuring line or battery, with input range of 0~52V (compatible with 12s lithium battery).	
20	VSER	Power positive	Flight control power input (ground wire can be branched out from common ground wire).	
3	PGND	Power ground	Flight control power input.	
22	VSER	Power positive		
4	PGND	Power ground	Connected to receiver Sbus bus interface, VSER can be used as flight control power input, or output to power up the receiver.	
23	VSER	Power positive		
24	Sbus_RX	Sbus receiving		
6	PWM1	PWM output channel 1	Connected to fixed-wing aileron servo.	

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Pin No.	Definition	Description	Remarks	Label
7	PWM2	PWM output channel 2	Connected to fixed-wing elevator/V-tail right servo/Flying wing right servo	
8	PWM3	PWM output channel 3	Connected to fixed-wing throttle servo.	
9	PWM4	PWM output channel 4	Connected to fixed-wing servo/V-tail left-wing servo/flying left-wing servo.	
10	PWM5	PWM output channel 5	Connected to electric regulator of quadrotor motor 4 (lower right, clockwise).	
25	PWM6	PWM output channel 6	Connected to electric regulator of quadrotor motor 1 (upper right, counterclockwise).	
26	PWM7	PWM output channel 7	Connected to electric regulator of quadrotor motor 2 (lower left, counterclockwise).	
27	PWM8	PWM output channel 8	Connected to electric regulator of quadrotor motor 3 (upper left, clockwise).	
28	PWM9	PWM output channel 9	Control signal of parachute opening servo/engine start motor control signal.	
5	DO1	Switch quantity output 1	Mission payload control signal, multiplexed for control of both photographing and payload power on/ off. Output current < 4mA. Photographing: effective for high level, externally connected for dedicated electronic shutter control line. Nacelle switch machine: Power on upon high level/power off upon low level, to be controlled after the external secondary processing.	
30	DO2	Switch quantity output 2	Shutdown control signal (TTL), effective for high level, externally connected to dedicated engine shutdown control line. It can be defined as the servo control PWM output of stability-increasing PTZ for aerial survey.	
29	DO3	Switch quantity output	Night flight light control signal (TTL), effective for high level (light on), externally connected to dedicated night flight light driver module. It can be defined as the servo control PWM output of stability-increasing PTZ for aerial survey.	
31	RPM1	Rotation speed signal 1	TTL pulse width, effective at high power level.	
32	RPM2	Rotation speed signal 2	TTL pulse width, effective at high power level , can be defined as flow meter input. (oil level sensor) .	

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Pin No.	Definition	Description	Remarks	Label
33	RX232_1	Serial port 1 receiving, 232	Telemetry information receiving, connected to ground telemetry control station.	
34	TX232_1	Serial port 1 transmission, 232	Telemetry information transmitting connected to ground telemetry control station.	
37	PGND	Power ground	Common ground wire.	
11	TX232_4	Serial port 4 transmission, 232	Mission payload control interface.	
12	RX232_4	Serial port 4 receiving, 232		
13	TX232_5	Serial port 5 transmission, 232	Connect the laser rang finder/standby remote controlling and telemetry communication serial port.	
14	RX232_5	Serial port 5 receiving, 232		
19	PGND	Power ground	Common ground wire.	
16	BOOT	BOOT signal	Used for flight control software and firmware updating. When firmware needs to be updated, short circuit the BOOT and VCC3 and then the flight control power-on automatically enters the program download mode. This function is designed for flight control with the serial number > 17331. When under the non-download mode, it is strictly prohibited to connect other devices!	BOOT
17	DGPS_RX	External DGPS signal serial receiving, TTL	Used for external DGPS data access, the serial port level is TTL.	DGPS
35	DGPS_TX	External DGPS signal serial transmitting, TTL		
18	PGND	Power ground	Common ground wire.	
15	SCL	External compass I <sup>2</sup> C interface - clock signal line	Used for external compass data accessing, I <sup>2</sup> C bus interface.	Compass
36	SDA	External compass I <sup>2</sup> C Interface - Data Cable		

Remarks:

- 1.VSER/PGND is the power supply shared by flight control and servo, with input range of DC4.0-9.0V; the internally defined identical base pins are interconnected, so that power supply can be input through any one or more groups of (VSER/PGND) base pins, while the other channels can be used for power supply output.
- 2.VCC5 is internal power supply, and external use is strictly prohibited.
3. The manufacturer provides the interface cable which can be directly connected to electric regulator, servo, etc.

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The S40/S50 leaves the factory with a 30mm long cable as its standard configuration, which is compatible with ESC, servo, receiver and other interfaces for quick installation and use.

S40/S50 conventional cable wiring diagram is shown in Figure 2.4a, S40/S50 integrated cable diagram shown in Figure 2.4b and Figure 2.4c.

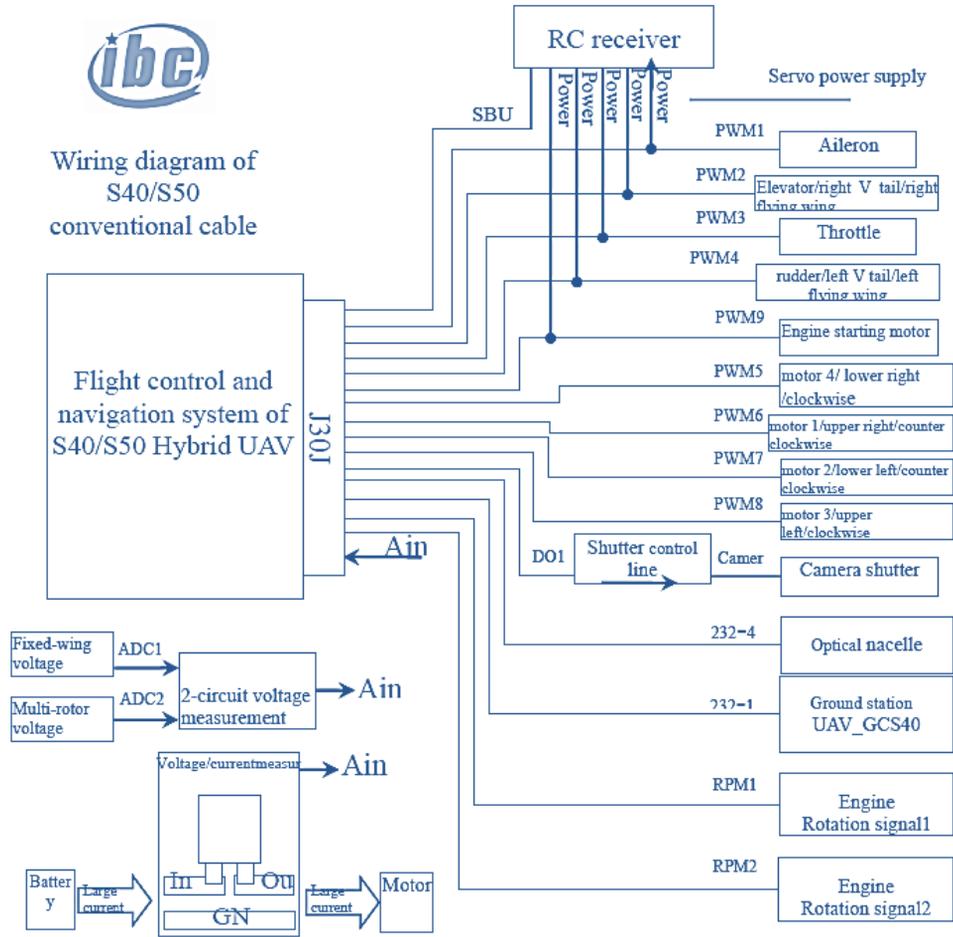


Fig.2.4a Wiring diagram of S40/S50 conventional cable



**Note:** The base pin of In+, Out+, GND in voltage/ current measurement shall be welded to the power line sufficiently, to ensure exceeding current capacity!

# S40/S50 flight control & navigation system

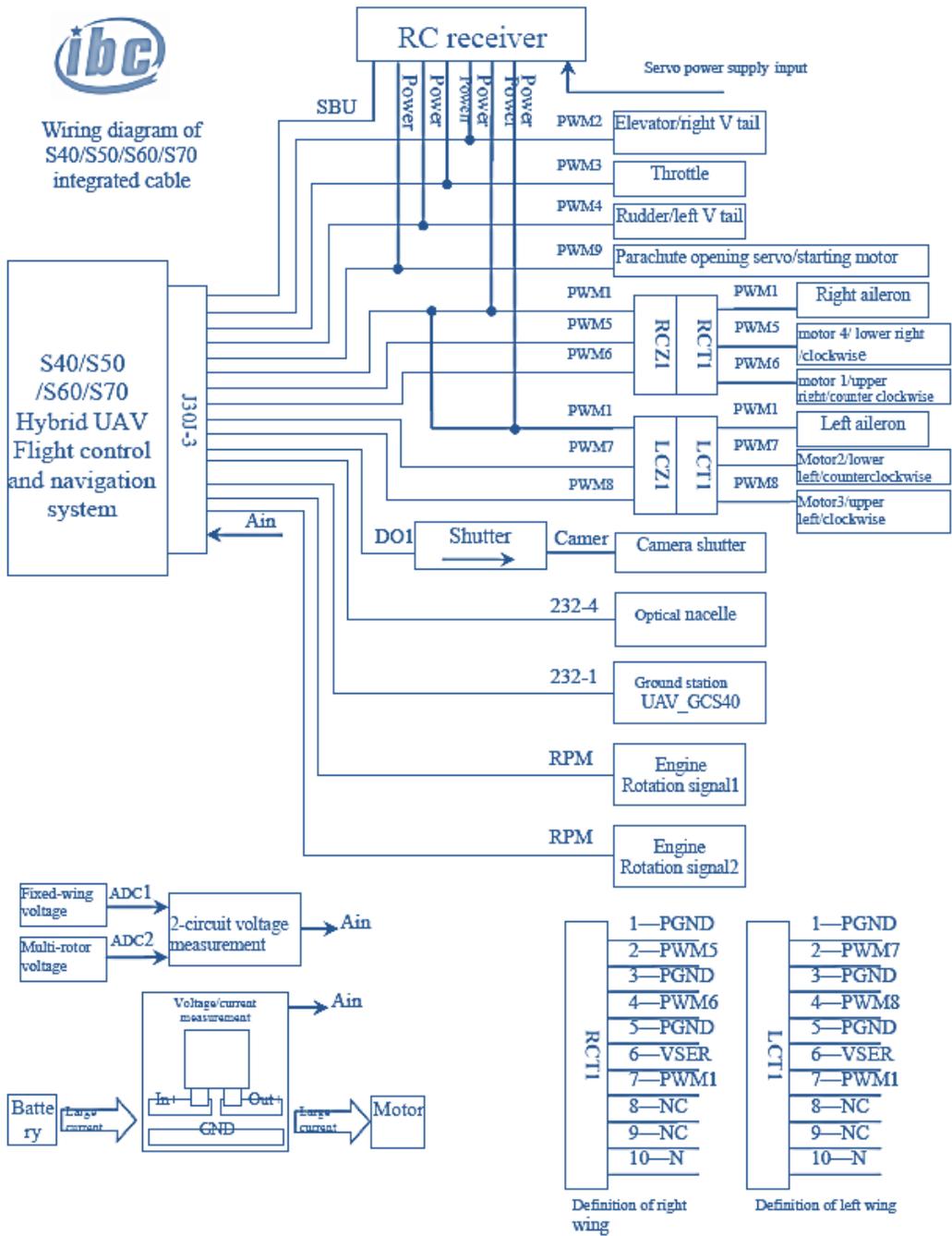


Fig.2.4b Wiring diagram of S40/S50/S60/S70 integrated cable (integration of empennage cable and fuselage)

**⚠ Note:** the base pin of In+, Out+, GND in voltage/ current measurement shall be weld to the power line sufficiently, to ensure exceeding current capacity!

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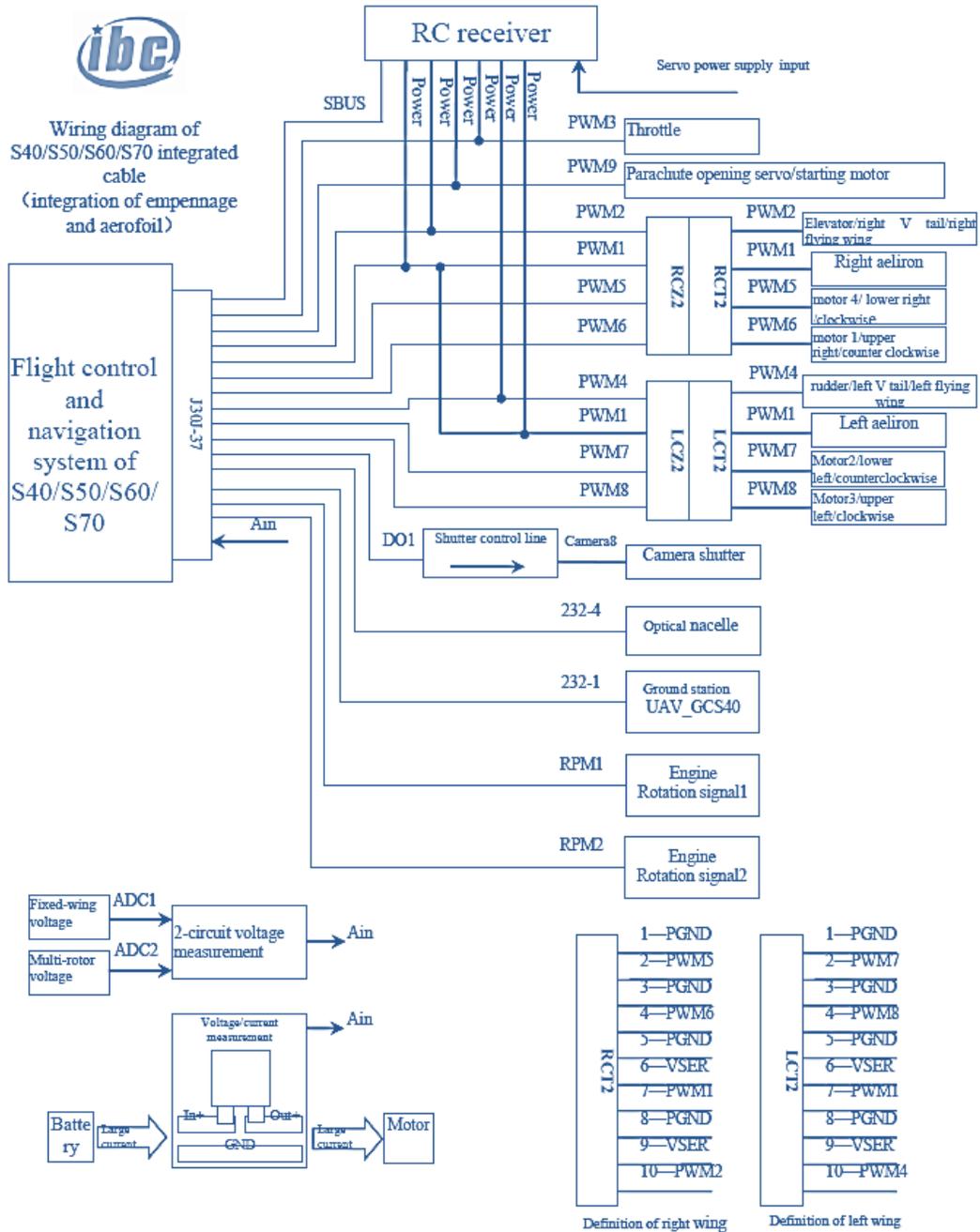
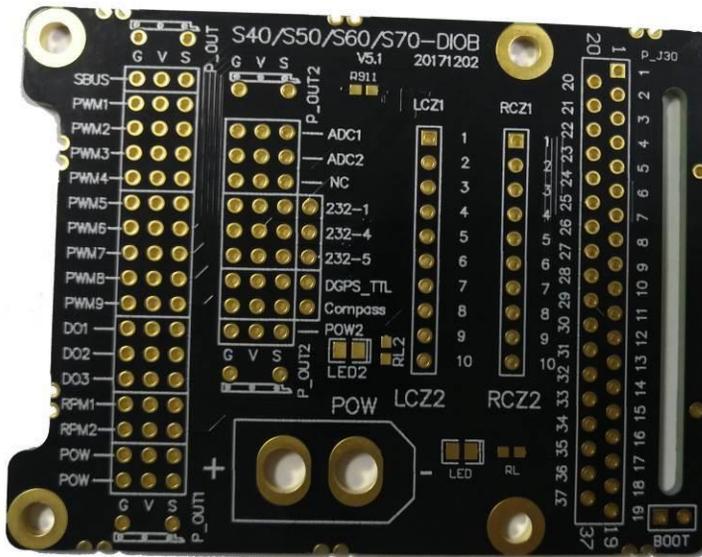


Fig.2.4c Wiring diagram of S40/S50/S60/S70 integrated cable (integration of empennage cable and aerofoil)

**⚠ Note:** the base pin of In+, Out+, GND in voltage/ current measurement shall be weld to the power line sufficiently, to ensure exceeding current capacity!

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Label	G	V	S	remarks	Label	G	V	S	Remarks
SBUS	Power ground	power+	Signal	-	RPM1	Power ground	power+	Signal	
PWM1	Power ground	power+	Signal	-	RPM2	Power ground	power+	Signal	
PWM2	Power ground	power+	Signal	-	POW	Power ground	power+	Empty	
PWM3	Power ground	power+	Signal	-	-	-	-	-	
PWM4	Power ground	power+	Signal	-	ADC1	Power ground	Empty	Signal	
PWM5	Power ground	power+	Signal	-	ADC2	Power ground	Empty	Signal	
PWM6	Power ground	power+	Signal	-	NC	Empty	Empty	Empty	
PWM7	Power ground	power+	Signal	-	232-1	Power ground	TX	RX	power+
PWM8	Power ground	power+	Signal	-	232-4	Power ground	TX	RX	power+
PWM9	Power ground	power+	Signal	-	232-5	Power ground	TX	RX	power+
DO1	Power ground	power+	Signal	-	DGPS_TTL	Power ground	GPS_TX	GPS_RX	power+
DO2	Power ground	power+	Signal	-	Compass	Power ground	SDA	SCL	power+
DO3	Power ground	power+	Signal	-	POW2	Power ground	power2+	Empty	
Notes: The interface board supports 2-circuit power input. The system automatically selects the higher voltage power supply for the flight control internal power supply, but the POW2 cannot supply power to the servo, and the servo power is input by the POW.									
LCZ2-1	Power ground	LCZ2-6	power+	-	RCZ2-1	Power ground	RCZ2-6	power+	
LCZ2-2	PWM7	LCZ2-7	PWM1	-	RCZ2-2	PWM5	RCZ2-7	PWM1	
LCZ2-3	Power ground	LCZ2-8	Power ground	-	RCZ2-3	Power ground	RCZ2-8	Power	
LCZ2-4	PWM8	LCZ2-9	power+	-	RCZ2-4	PWM6	RCZ2-9	power+	
LCZ2-5	Power ground	LCZ2-10	PWM4	-	RCZ2-5	Power ground	RCZ2-10	PWM2	

Fig.2.4d S40/S50 interface board diagram and definition

# S40/S50 flight control & navigation system

## 3. Remote Control

### 3.1 Remote control

S40/S50 is compatible conventional 8 or more channels (including 8 channels) Sbus or Sbus2 interface RC remote controller and receiver, and can execute the following functions by the RC remote controller:

- 1) The manual/autonomous control modes can be switched by the RC remote controller;
- 2) The fixed-wing and multi-rotor modes can be switched by the RC remote controller;
- 3) The RC remote controller can be used for registration of the parachute opening servo(starting motor);
- 4) The RC remote controller can execute unlocking, to prevent malfunction of the motor;
- 5) RC remote controller can remotely control the servo surfaces and attitude of fixed-wing UAV;
- 6) RC remote controller can remotely control the servo surfaces and attitude of multi-rotor UAV;
- 7) RC remote controller can execute “parachute opening”, “shutdown” and “engine start”;
- 8) The Fail Safe status of the RC remote controller is under monitoring;
- 9) RC remote controller can execute the “return” operation.



**Notes:** before the first electrification of the aircraft, please assure that the basic route and channel of the RC remote controller has been configured in accordance with Table 3.1; otherwise unexpected safety issues will arise.



**Notes:** The zero position fine adjustment of the RC remote controller should be kept at 0, otherwise, it cannot adapt to both fixed-wing and multi-rotor at the same time, which brings safety risks.



**Skills:** after servos travel setting and zero position calibration of S40/S50, it can operate without RC remote controller, but the operator usually prefers using RC remote controller, because it is able to easily and quickly take over control of the aircraft and it is also a safety measure in case of an emergency.



**Tips:** for “shutdown” function of RC remote controller, knob channel is recommended to be selected, to prevent the general “switch” channel from causing sudden “shutdown” action after being touched accidentally.



**Tips:** When the user does not need the “Return Switch” function of the RC remote controller, this channel may not be set.

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Table 3.1 Definitions of channels of RC remote controller

Channel	Definition	Travel	Remarks
ch1	Aileron	-100% to +100%	Maintaining default configuration
ch2	Elevation	-100% to +100%	Maintaining default configuration
ch3	Throttle	-100% to +100%	Maintaining default configuration (Futaba needs reverse direction)
ch4	Direction	-100% to +100%	Maintaining default configuration
ch5	Manual/autonomous switching	$\leq -60\%$ : manual recommended: -100% $-60\%$ to $+20\%$ : semi-auto recommended: 0% $\geq +20\%$ : full-auto recommended: 100%	Three-segment switch, generally default configuration is OK
ch6	Parachute opening or engine starting	-100% to +100%	Calibration via flight control is required
ch7	Stop	$> -60\%$ : stop recommended: 100% $\leq -60\%$ : cancel stop recommended: -100%	Rotary or 2 segment switch, generally default configuration is OK
ch8	Aircraft mode switch	$\leq -60\%$ : multi-rotor mode recommended: -100% $-60\%$ to $+20\%$ : transmission mode recommended: 0% $\geq +20\%$ : fixed wing mode recommended: 100%	Three-segment switch, generally default configuration is OK.
ch9	Home switch	$\geq +20\%$ : return recommended: 100% Home switch $\leq -60\%$ : return preparation recommended: -100%	Maintaining default configuration; Homing is executed when Home switch changes from homing preparation position to homing position
ch10	Engine start switch (when ch6 is occupied for parachute opening, engine can be started with ch10 and the default is invalid )	-100% to +100%	Needs calibration through flight control



**Notes:** In order to prevent the RC remote controller of multi-rotor from malfunctioning in the full-auto mode, sending “take-off”, “cruise”, “landing”, “waypoint switching” or one-key landing command will set the RC remote controller in Failure under full-auto mode (backward/forward, left/right, yaw, and altitude can not be remotely controlled), unlocked by continuous action in the throttle lever -> upper -> medium -> upper -> (interval <3s). No failure mode for manual and semi-auto conditions.

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Table 3.2 Application of the channels for multi-rotor mode RC remote controller

Channel	Definition	Manual	Semi-auto	Full-auto RC remote controller not in Failure	Remarks
ch1	Aileron	Rolling attitude [-25°, 25°]	Rolling attitude [-25°, 25°]	If GPS positioning is invalid, rolling attitude [-25°, 25°] ; If GPS positioning is normal and hovering, lateral velocity [-3m/s, 3m/s]; When GPS positioning is normal and flying in route, effective.	
ch2	Elevation	Pitch attitude [-25°, 25°]	Pitch attitude [-25°, 25°]	If GPS positioning is invalid, pitch attitude [-25°, 25°] ; If GPS positioning is normal and hovering, longitude velocity [-3m/s, 6m/s] ; If GPS positioning is normal and flying in route, effective.	
ch3	Throttle	Throttle servo [0%, 100%]	Throttle servo [0%, 100%]	Hovering: Elevation(vertical)velocity [-1.5m/s, 6m/s] ; Flight in normal route, effective.	
ch4	Direction	Yaw angle velocity[-120°/s, 120°/s]	Yaw angle velocity[-120°/s , 120°/s]	Hovering or GPS positioning is invalid: yaw angle velocity[-120°/s, 120°/s]; Other situation (normal GPS positioning is during flight in route): ineffective	
ch5	Manual/autonomous switch	Effective	Effective	Effective	
ch6	Parachute opening or starting	Effective	Effective	Effective	
ch7	Stop	Effective	Effective	Effective	Engine stop
ch8	Aircraft mode switch	Effective	Effective	Ineffective	
ch9	Home switch	Ineffective	Ineffective	Effective; Non-ground mode, RC not subject to distance exceeding, the return switch starts returning when it changes from the return preparation position to the returning position.	

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**Table 3.3 Application of the channels for fixed-wing mode RC remote controller**

Channel	Definition	Manual	Semi-auto	Full-auto	Remarks
ch1	Aileron	Aileron servo [-100%, 100%]	Roll attitude [-30°, 30°]	Ineffective	
ch2	Elevation	Elevator [-100%, 100%]	Pitch attitude [-20°, 20°]	Ineffective	
ch3	Throttle	Throttle servo [0%, 100%]	Throttle servo [0%, 100%]	Ineffective	
ch4	Direction	Rudder [-100%, 100%]	Yaw angle velocity [-90°/s, 90°/s]	Ineffective	
ch5	Manual /autonomous switching	Effective	Effective	Effective	
ch6	Parachute opening or Engine start	Effective	Effective	Ineffective	
ch7	Shutdown	Effective	Effective	Ineffective	
ch8	Aircraft mode switching	Effective	Effective	Ineffective	
ch9	Return switch	Ineffective	Ineffective	Effective; Non-ground mode, RC not subject to distance exceeding, the return switch starts return when it changes from the return preparation position to the return position.	

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Table 3.4 Application of the channels for transmission mode RC remote controller

Channel	Definition	Manual	Semi-auto	Full-auto
ch1	Aileron	fixed-wing aileron servo [-100%,100%] Multi-rotor roll attitude [-30°,30°]	Roll attitude [-30°,30°]	Ineffective
ch2	Elevation	Ineffective Fixed-wing pitch control surface at 0 position; Multi-rotor pitch attitude at 0°	Ineffective Pitch attitude at 0°	Ineffective
ch3	Throttle	Fixed-wing throttle servo [0%,100%] Multi-rotor maintains hovering throttle	Fixed-wing throttle servo [0%, 100%]; Multi-rotor maintains hovering throttle	Ineffective
ch4	Direction	Fixed-wing rudder [-100%,100%] Multi-rotor yaw angle velocity [-90°/s,90°/s]	Yaw angle velocity [-90°/s,90°/s]	Ineffective
ch5	Manual/autonomous switching	Effective	Effective	Effective
ch6	Parachuting opening or Engine start	Effective	Effective	Ineffective
ch7	Shutdown	Effective	Effective	Ineffective
ch8	Aircraft mode switching	Effective	Effective	Ineffective
ch9	Returning switch	Ineffective	Ineffective	Effective; Non-ground mode, RC not subject to distance exceeding, the return switch starts returning when it changes from the return preparation position to the return position.

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**Notes:** The fail-safe (F/S) function of the RC remote controller manual / autonomous switching channel should generally be set valid. If this channel does not possess the fail-safe (F / S) function, the fail-holding function is required. Otherwise, it will severely interfere flight safety.



**Notes:** Each zero position fine adjustment of RC remote controller shall be kept at 0, otherwise, it cannot adapt to both fixed-wing and multi-rotor at the same time, which brings safety risks.



**Notes:** the “Aileron”, “Elevation”, “Throttle” and “Direction” channels for RC remote controller execute different functions in the manual/semi-auto/full-auto modes, as shown in tables 3.2, 3.3 and 3.4.



**Skills:** after configuration of RC remote controller, please connect S40 and GCS40 to verify:

- The manual/autonomous modes can be switched by the RC remote controller;
- The fixed-wing/multi-rotor modes can be switched by the RC remote controller;
- Stop can be operated via RC remote controller.

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## 3.2 Servo (Travel) calibration

After configuration of basic travel and channels for a RC remote controller and before the first flight, it is required to calibrate the servos based on the actual travel of each servo and record them in a flight control unit.

- Each servo of multi-rotor do not need calibration ;
- The servo limit positions as well as positive and negative polarities of aileron, elevator, rudder and throttle under fixed wing mode are adjusted by the GCS40 software.

There is no need to enter the “calibration” mode, nor use the RC remote controller to adjust travel (keep defaulted configuration; travel: -100%~+100%; normal polarity (the throttle channel of Futaba remote controller shall be reversed.));

- The limit position as well as positive and negative polarities of the parachute opening servo (engine start) shall be adjusted by the combination of RC remote controller and GCS40 software, and it needs to enter the “calibration” mode.
- After setting the throttle limit position as well as positive and negative polarities under the fixed wing mode, typical positions such as idling position, descending position, cruising position and climbing position shall be calibrated, for throttle control in case of airspeed failure.

The idling position is mainly designed for the oil-powered engine.

After setting, the automatic limiting throttle of the flight controller is above the idling position, and the idling position of the motor can be set as the minimum throttle.

 **Notes:** the servo limit positions as well as positive and negative polarities of aileron, elevator and rudder under fixed wing mode do not need “calibration”, which can be set by the GCS40 (as shown in Table 3.5 below); the RC remote controller is kept as the default configuration (travel: -100%~+100%; normal polarity).

The servo zero positions of aileron, elevator and rudder shall not be “calibrated” by software; during flight, the flight controller will automatically compensate the zero position deviation.

However, the servo lever shall be adjusted mechanically in case of high zero position deviation.

# S40/S50 flight control & navigation system

**Table 3.5 Definitions of limit positions of aileron, elevator, and rudder under fixed-wing mode**

Item	Negative limit	Positive limit	Remarks
<b>Aeliron</b>	-KRlimit	+KRlimit	The lateral control law interface of GCS4 is defaulted as -KRlimit=-100, +KRlimit=100, if the polarity is opposite, -KRlimit=100, +KRlimit=-100
<b>Elevator</b>	-KPlimit	+KPlimit	The longitude control law interface of GCS4 is defaulted as -KRlimit=-100, +KRlimit=100, if the polarity is opposite, -KRlimit=100, +KRlimit=-100
<b>Rudder</b>	-KYlimit	+KYlimit	The course control law interface of GCS40 is defaulted as -KRlimit=-100, +KRlimit=100, if the polarity is opposite, -KRlimit=100, +KRlimit=-100
<b>Throttle</b>	-KVlimit	+KVlimit	The velocity control law interface of GCS40 is defaulted as -KVlimit=-100, +KVlimit=100, if the polarity is opposite, -KVlimit=100, +KVlimit=-100

 **Notes:** For aircraft with fixed-wing modal “V-tail” or “flying wing”, the RC remote controller does not have to set the direction and lifting mixed control, and the S40 requires the corresponding tail plane layout, otherwise the flight control will enable interior mixed control!

 **Notes:** Each zero position fine adjustment of RC remote controller shall be kept at 0, otherwise, it cannot adapt to both fixed-wing and multi-rotor at the same time, which brings safety risks.

 **Prohibited:** during flight, the calibration mode shall not be activated, or grave safety issues will ensue! The calibration mode can only be activated on the ground.

 **Notes:** after enter “calibration” mode, the RC remote controller can be used to operate servos such as throttle and parachute opening under the “Manual” control mode, or operate through the GCS40 interface under the “Full-autonomous” or “Semi-autonomous” control mode.



## **Skills: calibration for electronic adjustment of the motor:**

1. It is suggested to calibrate the electrical adjustment of motor by the Remote Controller and receiver directly prior to assembly.
2. Under multi-rotor mode, after the flight controller enters the calibration mode, the PWM channel of quadrotor will follow the RC remote controller directly, which can be used for calibrating the electrical adjustment of motor of the quadrotor: energize flight controller -> enter the calibration mode -> set the throttle at the maximum position -> energize the motor of the quadrotor -> calibrate electrical adjustment of motor of the quadrotor

# S40/S50 flight control & navigation system



**Prohibited:** If the multi-rotor motor does not respond properly and needs to enter multi-rotor calibration mode, the multi-rotor propeller must be first disassembled to prevent accidental injury.

Specific steps of calibrating typical positions of the throttle are as follows:

1. Establish connection between the ground station software GCS40 and the flight controller.
2. Switch to the manual control mode by the RC remote controller.
3. Enter “throttle lever calibration”, after which the throttle position will follow the RC remote controller entirely.
4. Use the RC remote controller to control the throttle to reach and stay at corresponding position, set the “idling position”, “descension position”, “cruise position”, “climb position” successively. “Minimum (Eng. Stop) position” and “maximum position” are not required to be calibrated.
5. Exit throttle lever calibration, meanwhile the calibrated throttle positions are automatically saved in the flight control unit.
6. Enter “throttle lever calibration” again.
7. Switch to the “Full-autonomous” or “Semi-autonomous” control mode by the RC remote controller.
8. Operate “minimum (Eng. Stop) position”, “idling position”, “descending position”, “cruise position”, “climb position” and “maximum position” through the GCS40 interface successively; the throttle will follow the command given by GCS40, to ensure all positions of the throttle are normal after calibration.
9. Exit “throttle lever calibration”.

Specific steps of position calibration of parachute opening servo (engine starting motor) are as follows:

1. Establish connection between ground station software GCS40 and the flight control.
2. Switch to the manual mode by the RC remote controller.
3. Enter “other servo calibrations”, after which the parachute opening servo (engine starting motor) will follow the RC remote controller entirely.
4. Use the RC remote controller to control the parachute opening servo(engine starting motor) to reach and stay at corresponding position (see Table 3.6), and set the “negative servo limit”, “zero position of servo” and “positive servo limit” successively.
5. Exit “other servo calibration”, meanwhile the calibrated servos positions are automatically saved in the flight control unit.
6. Enter “other servo calibration” again.
7. Switch to the “Full-autonomous” or “Semi-autonomous” control mode by the RC remote controller.
8. Operate “negative servo limit”, “zero position of servo” and “positive servo limit” on the GCS40 interface successively; the parachute opening servo(engine starting motor) will follow the command given by GCS40; ensure all positions are normal after calibration.
9. Exit “other servo calibration”.

# S40/S50 flight control & navigation system

**Table 3.6 Definitions of the positions in other servo calibrations**

Item	Negative limit	Zero position	Positive position	Remarks
<b>PWM9 Parachute opening</b>	Parachute non-opening position	Parachute non-opening position	Parachute opening position	
<b>PWM9 Engine start</b>	Not start position	Not start position	Start position	

### 3.3 Unlocking/locking

In order to prevent malfunction of motor/oil engine, electrified S40/S50 is locked by default and the motor/oil engine automatically maintains idling. Use the RC remote controller or GCS40 ground station software to execute unlocking(arm)/locking(disarm).

Conditions for unlocking by the RC remote controller (internal “Eight” character):

- 1) The “shutdown” and “parachute opening” switches are in invalid position.
- 2) Throttle at the minimum position.
- 3) Elevator lever at the maximum (positive limit).
- 4) Right rudder at the maximum (positive limit).
- 5) Left aileron at the maximum (negative limit).
- 6) Keeps on over 3s.

Conditions for locking by the RC remote controller (external “Eight” character):

- 1) Manual control mode.
- 2) Throttle at the minimum position.
- 3) Elevator lever at the maximum (positive limit).
- 4) Left rudder at the maximum (negative limit).
- 5) Right aileron at the maximum (positive limit).
- 6) Keeps on over 3s.

After startup and unlocking by the RC remote controller, if no action is executed under the following conditions, it will be locked automatically:

- 1) Manual or semi-auto control mode.
- 2) Throttle at the minimum position.
- 3) Elevator at zero position.
- 4) Rudder at zero position.
- 5) Aileron at zero position.
- 6) Keeps on over 20s.

Conditions for unlocking by ground station software:

- 1) Full-auto control.
- 2) GPS positioning is normal.
- 3) “Takeoff” command is effective or the “Cruise” command sent during hovering is effective.

# S40/S50 flight control & navigation system



**Notes:** S40/S50 will be locked automatically and enter the “ground segment” after shutdown.



**Tips:** if normal unlocking cannot be executed by the RC remote controller, confirm the following: are the “shutdown” and “parachute opening” switches in invalid position?

Are all joysticks at the zero position upon fine adjustment?

Is the travel of the remote control channel changed?

If it is, recovery or servos (travel) calibration shall be conducted in accordance with Section 3.2.

# S40/S50 flight control & navigation system

## 4. Route and Protection

S40/S50 provides 5 types of routes: user route, home route, circle route, takeoff/landing route and emergency landing point.

The user route is planned and edited by the user based on the mission needs, which includes program control of mission loads; The other routes are special routes which don't involve program control of mission loads.

### 4.1. User route

S40/S50 provides 8 routes and each route can be added to 800 waypoints. Generally, user route has 2 attributes: route ID and route circulation.

The route ID is the only identification mark for the route, ranging from user route1 to user route 8.

If the route circulation setting of a route is effective, it will automatically switch to the first waypoint after reaching the last waypoint and circulating the route.

Each waypoint in a user route has the following attributes: waypoint ID, longitude, latitude, altitude, speed, waypoint switching mode, attitude control mode, circling rounds, mission load control and mission repetition interval.

The user can edit these attributes when planning the route. Significance of each attribute are as follows:

**Waypoint ID:** the only identification symbol of the waypoint.

**Longitude, latitude and altitude:** three-dimensional coordinates of the waypoint.



**Notes:** the route height refers to the altitude.

**Speed:** target flight speed (airspeed) of the aircraft in the route segment from current position to the desired waypoint.



**Notes:** if it is set at 0, the flight controller will automatically apply the airspeed setting upon departure.

# S40/S50 flight control & navigation system

**4. Waypoint switching mode:** any waypoint in the route can be set to the following switching modes: normal switching, circling route, autonomous landing, fixed-point hover and home route.

- Normal: upon arrival at the waypoint, the system automatically switches to the next waypoint of the route.
- Circle: upon arrival at the waypoint, the system automatically switches to the circling route (this waypoint as the “center of circle”).
- Autonomous landing: upon arrival at the waypoint, the system automatically switches to the landing mode (this waypoint as the “landing point”).
- Fixed-point hovering: upon arrival at the waypoint, the system automatically switches to multi-rotor mode and starts hovering at the waypoint.



**Notes: S40/S50 does not apply this function yet.**

- Home route: upon arrival at the waypoint, the system automatically switches to the home route.

**5. Altitude control mode:** the altitude control mode of the aircraft flying from the current position to the desired waypoint, including normal control, slope control, circle first and circle at point.

- Normal control: the aircraft flies directly to the target waypoint while ascending/descending to the target altitude with maximum speed.
- Slope control: the aircraft flies directly to the target waypoint while controlling the altitude based on the oblique line between the current point and target waypoint.
- Circle first: the aircraft ascends/descends circling to the target altitude first and then flies to the target waypoint.
- Circle at point: the aircraft flies to the target waypoint at the current altitude first and then ascends/descends circling to the target altitude.

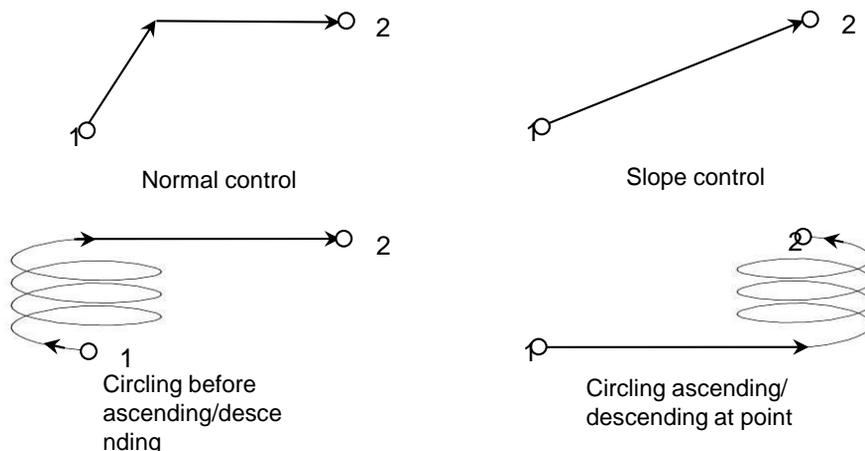


Fig.4.1 Diagram of altitude control mode

## S40/S50 flight control & navigation system

**6. Circling rounds:** if the selected waypoint switching mode is circling route, the “circling rounds” attribute is effective.

After completing the circling rounds, the aircraft automatically exits the circling route and switches to the next waypoint.

**7. Task at WPT:** S40/S50 provides one-circuit mission payload control signal (DO1) which can control photographing or the nacelle switch.

This signal is multiplexed by the two actions, defaulted as photographing.

Pod switch is one-time action, but photographing is repetitive; photographing also needs a preset repetition distance to execute spacing photographing.

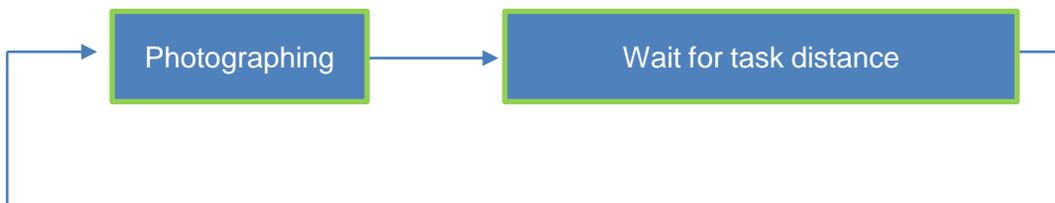
**! Notes: the mission action is executed after arrival at the waypoint.**

**8. Repetition distance:** the distance between two photographing actions.

This attribute is only effective for photographing action.

If the mission spacing is at zero, photographing action will be executed only once.

The photographing process is shown in Figure 4.2.



*Fig.4.2 Implementation of photographing*

**! Notes:** during the waypoint editing, airspeed can be set on demands, but the user need to ensure that airspeed is within reasonable range, otherwise it brings safety issues! If there is no special requirement for flight speed, the airspeed is defaulted at 0 and the flight control automatically execute the cruising airspeed of factory default.

## S40/S50 flight control & navigation system



**Tips:** “fixed-point hover” function in waypoint switch mode of S40/S50 has not been activated.

If it has to switch to the multi-rotor mode during fixed-wing flight, GCS40 can send the “mandatory multi-rotor” command; after completion of the multi-rotor mission, it will send the “restore automatic switch” command.



**Tips:** the waypoint task action of S40 is executed after arrival at the waypoint!

This action will be maintained during the next flight segment until a new waypoint task motion is commanded.



**Tips:** if photographing and nacelle switch selected by the waypoint task action are effective at the same time, only photographing will be executed, because these two actions share the same interface and can not be activated at the same time, while photographing is the priority.



**Tips:** only in the full-auto mode, will the S40/S50 automatically switch to a waypoint; in the manual or semi-auto mode, it will not automatically switch to a waypoint.

# S40/S50 flight control & navigation system

## 4.2 Circle route

S40/S50 automatically generates a circling route, which is defined by the circling center and circling radius.

Normally, the position point at which the aircraft cuts into the circling routes is the circling center which the aircraft circles around until it exits the circling route.

The default radius of the circling route is 150m, rightward.

The task of circling route maintains the original status and can not act automatically.



**Tips:** when switching from manual or semi-auto to full-auto, S40/S50 is in the circling route by default ; in the manual or semi-auto mode, the current position of aircraft automatically refresh to the circling center and altitude of the circling route.



**Tips:** S40/S50 will not execute any task when in circling route or homing route and the mission channel maintains the original status without any action.



**Notes:** if the data of the current route is abnormal ( errors in the uploaded or saved route data), S40/S50 will automatically switches to circling route.

*Fig.4.1 Diagram of altitude control mode*

# S40/S50 flight control & navigation system

## 4.3 Homing (return) route

S40/S50 automatically generates a homing route which has only one waypoint.

The last position point (longitude, latitude) of the aircraft in the “ground segment” is usually the “home” position and the default altitude of “home” is the ground height+ Min Relative Height + 20m.

The user can also reset the homing route by editing a new route.

If the aircraft enters the homing route, it will fly in the straight line from the current point to “home”. Upon arrival at “home”, it automatically switches to the automatic landing mode (hybrid UAV) by default.

The attributes of the homing route are as follows:

**Waypoint ID:** 0

**Longitude and latitude:** the last position point (longitude, latitude) of the aircraft in the “ground segment” by default.

**Altitude:** ground height + Min Relative Height + 20m by default.

**Waypoint switching mode:** automatic landing

**Altitude control mode:** circle at point

**Task action:** no task

**Route Circulation:** no circulation



**Tips:** the last position point (longitude, latitude) of the aircraft in the “ground segment” is the “home” position; the “home” altitude is ground height + Min Relative Height + 20m by default.



**Tips:** S40/S50 does not execute any mission when in circling route or homing route and the mission channel maintains the original status without any action.



**Tips:** usually, the user does not need to alter the homing route, but can download the homing route to check the “home” position. If the user has reedited the homing route, the distance of the original point (the distance from the current point to “home”) will change.



**Tips:** for a hybrid or multi-rotor UAV, the waypoint switching mode for homing route is automatic landing; for a fixed-wing UAV, the waypoint switching mode of homing route is circling route (always circling)

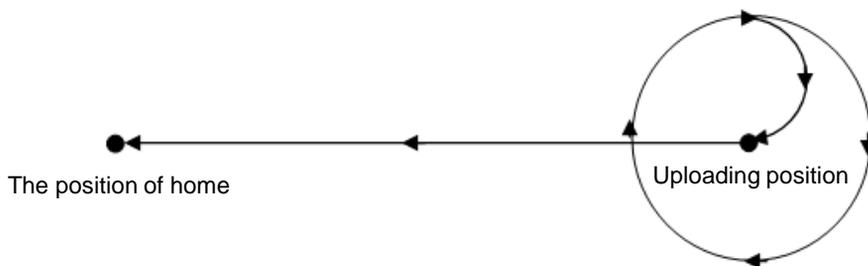
# S40/S50 flight control & navigation system

## 4.4 Takeoff/landing route

Takeoff/landing route is mainly designed for the automatic taxiing-takeoff, landing of the fixed-wing UAV.

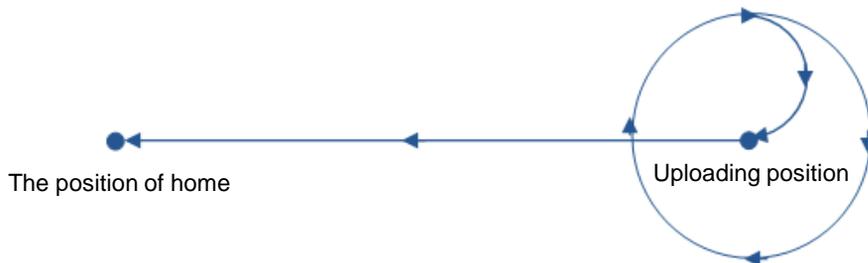
Hybrid UAV can generate the landing route reducing altitude at appointed point with one-key action, enabling the aircraft to automatically circle and reduce altitude at the upload waypoints (reducing to the “home” altitude, which is the ground elevation + Min height limit+ 20m by default), straight return, reduce airspeed, switch to multi-rotor in advance based on distance and land home vertically.

To ensure the landing effect, it is generally required that the distance between the upload waypoint and the position of “home” exceed 500m. Landing process is shown in the diagram



Hybrid UAV can generate the landing route reducing altitude at original point with one-key action, enabling the aircraft to automatically circle and reduce altitude at the upload waypoints (reducing to the “home” altitude, which is the ground elevation + Min height limit+ 20m by default), straight return, reduce airspeed, switch to multi-rotor in advance based on distance and land home vertically.

To ensure the landing effect, it is generally required that the distance between the upload waypoint and the position of “home” exceed 500m. Landing process is shown in the diagram



One-key generating the landing route (reducing altitude at original point) of hybrid UAV

# S40/S50 flight control & navigation system

**Notes:** it can use one-key action to generate the landing route reducing altitude at appointed point, enabling the aircraft to automatically circle and reduce altitude at the upload positions, straight return, reduce airspeed, switch to multi-rotor in advance based on distance and land home vertically.

In order to ensure the landing effect, it is generally required that the distance between the upload waypoint and the location of "home" exceeds 500m.

**Notes:** When landing in at appointed point while in a compound route, just double-click the right button of the circling point, and then "Upload as the landing route", only the circling center will be in effect during this operation.

The other controls will be completed automatically by the flight controller, circling reducing attitude, straight return, reduce airspeed, switch to multi-motor in advance based on distance, and land home vertically.

**Notes:** When landing in at original point while in a compound route, just double-click the right button of the circling point, and then "Generate the landing route", only the circling center will be in effect during this operation.

The other controls will be completed automatically by the flight controller, circling reducing attitude, straight return, reduce airspeed, switch to multi-motor in advance based on distance, and land home vertically.

**Notes:** Fixed-wing mode can not execute "Landing" command of the main interface.

Diagram of the one-key generating the landing route

Circle Center And Radius

Circle Center

LON 116.460771 °

LAT 40.251564 °

Circle Radius

Radius 200 m(0~65535)

Circles

Counts 5 (0~250)

Looping

Target Tracking

Lock Target

Upload to Circling Point

Using Circle Radius

Upload to Landing Course Double Click

# S40/S50 flight control & navigation system

## 4.5 Emergency landing point

S40/S50 can be set maximally to 100 emergency landing points, used for the automatic landing in case of emergency.

This function is only applicable to hybrid/multi-motor UAV and inapplicable for fixed-wing UAV.

An emergency landing point only needs the longitude, latitude and altitude to be set.

In case of an emergency, S40/S50 will automatically take protective measures based on the user's protection setting and will select the nearest point between the preset emergency landing points and the position of "home" as the emergency landing point.



**Notes:** Emergency landing point is applicable to hybrid or multi-motor UAV

# S40/S50 flight control & navigation system

## 4.6 Emergency protection

S40/S50 has a sophisticated emergency protection system which can provide protection against low voltage, low oil level, abnormal attitude, abnormal altitude, low accuracy of GPS positioning, navigation system failure, breach of safety limit, breach of control radius and remote control failure, etc.

Specific protection objects and protective measures are as shown in Table 4.1.

Protection objects	Protective measures	Description
Main battery voltage lower than homing voltage	Homing	The protective measure can be set effective or ineffective.
Main battery voltage lower than emergency landing voltage	Emergency landing (fly to the emergency landing position in fixed-wing mode)	The protective measure can be set effective or ineffective.
Low oil level	Homing	Effective only for oil fueled aircraft; this protective measure can be set as effective or ineffective.
Low rotation speed of fixed-wing engine	Emergency landing if both engines stop. Homing if single engine stops.	Effective only for oil fueled aircraft; this protective measure can be set as effective or ineffective.
Low accuracy of GPS positioning	Hovering at fixed altitude (angular rate maintained) Homing after restoration of normal GPS positioning	The protective measure is always effective.
Abnormal attitude	Emergency landing	The protective measure is always effective.
Abnormal altitude	Emergency landing; If parachute is available at an altitude higher than 250m, parachute is deployed.	The protective measure is always effective.
Flight altitude in cruising segment lower than the Min altitude limit	Emergency landing	The protective measure is always effective.
Breach of the maximum control radius	Homing	The protective measure is always effective.
Protection against breach of safety limit	Emergency landing; If parachute is available at an altitude higher than 250m, parachute is deployed.	The protective measure is always effective.
Aircraft hardware failure	Homing	The protective measure is always effective.
Remote control failure	Switch to full-auto control mode.	The protective measure is always effective.
Navigation system failure	Parachute, if any, is deployed.	The protective measure is always effective.
Overtime communication outage	Homing	The protective measure is always effective.

## S40/S50 flight control & navigation system



**Notes:** if the protective measure is “homing”, the aircraft returns in the fixed-wing mode; upon arrival at “home”, it automatically switches to multi-rotor mode and lands vertically.

If the protective measure is “emergency landing”, the aircraft directly switches to multi-rotor mode and selects the nearest point between the preset emergency landing points and the position of “home” as the emergency landing point.



**Notes:** S40/S50 has three working states: normal state (control mode in green), calibration state (control mode in blue) and protection state (control mode in red).

The calibration state and protection state are abnormal working conditions, need to be vigilant!



**Notes:** calibration mode has no protection; ground segment has no protection; manual/semi-auto modes have no protection.



**Notes:** under protection conditions, waypoint switch can not be executed by the ground software GCS40.



**Notes:** for a protection object which can be set as effective or ineffective, the user can choose to or not to use any protective measure based on the actual flight conditions.

The protective measure is set as ineffective, S40/S50 can still give alarm on the status of each protection object, but will not take any protective measure.



**Tips:** The following are examples of protection,

- if the main battery voltage of an in-flight UAV is lower than homing battery and has continued a certain time, the system automatically applies the protection mode and switches to the homing route; if the system voltage restores to normal again, the system automatically exits the protection mode and executes the homing route.
- If the user wants to continue the mission instead of returning home, the waypoint switch through the ground station software GCS40 is required to resume the normal mission route.
- If the system voltage cannot restore to normal level and maintains the protection mode, while the user does not want to go home but to continue the mission, the waypoint cannot be switched.

Only when the protection configuration against low voltage is cancelled and the system exist the protection mode, can the aircraft execute normal waypoint switching function.

# S40/S50 flight control & navigation system

## 5. Flight Control

### 5.1 Control mode

S40/S50 has three flight control modes: manual, semi-auto, full-auto.

**Manual mode:** in fixed-wing mode, the RC remote controller will directly control the rudder surface and throttle lever of the aircraft; in multi-rotor mode, the RC remote controller controls the flight attitude and throttle lever of the aircraft, the same as in semi-auto mode.

**Semi-auto mode:** RC remote controller controls the flight attitudes and throttle levers of the UAV.

**Full-auto mode:** fly in the preset route and execute the formulated route missions.



**Notes:** the switching modes among the manual, semi-auto and full-auto modes of S40/S50 are completed by RC remote controller. S40/S50 will automatically switch to full-auto mode when RC remote controller conducts over-distance protection.

### 5.2 Control parameter



**Notes:** In order to avoid flight risk caused by errors in parameter adjustment, GCS40 generally does not disclose the pop-up interface of parameter adjustment including the installation calibration, longitudinal control law, heading course control law, rolling control law, speed control law, factory setting 1, factory setting 2 and etc.

If the user needs to adjust the parameter, please contact with the manufacturer. For details on the adjustment of control parameters, please refer to the technical documents provided by the manufacturer.

S40/S50 has two sets of control parameters: fixed-wing and multi-rotor, which shall be set separately under the fixed-wing mode and multi-rotor mode.



**Prohibited:** do not set the control parameter of multi-rotor in fixed-wing mode or set the control parameter of fixed-wing in multi-rotor mode, otherwise severe safety issue will be caused.

# S40/S50 flight control & navigation system

## 5.2.1. Control mode

The fixed-wing control channels of S40/S50 include longitudinal, course heading, lateral and speed channels. Longitudinal and course heading channels respectively include internal loop and external loop.

The internal loop completes attitude control with the update frequency of 25Hz, while the external loop completes position control with the update frequency of 10Hz. Both internal and external loops apply PID controller.

- Longitudinal channel completes altitude/pitch control.
- Course channel completes horizontal position/course heading control.
- Lateral channel completes roll attitude control.
- Speed channel completes airspeed control, with the update frequency of 10Hz.



**Notes:** when the speed channel is normal, the flight control will execute the closed-loop control of airspeed by default; if the airspeed control is invalid or the airspeed control is not selected, the three-stage throttle (climbing throttle, cruising throttle, descending throttle) control strategy will be deployed.

## 5.2.2 Multi-rotor mode

The multi-motor control channels of S40/S50 include longitudinal, course heading and lateral channels. Each channel includes inner loop and outer loop.

The inner loop is designed for attitude control with the update frequency of 200Hz, while the outer loop is for position/speed control with the update frequency of 25Hz. Both inner and outer loops apply PID controller.

- Outer loop of longitudinal channel completes altitude control.
- Inner loop of longitudinal channel completes pitch attitude control.
- Outer loop of course heading channel completes longitudinal distance/longitudinal speed control.
- Inner loop of course heading channel completes course angle control.
- Outer loop of lateral channel completes lateral distance/lateral speed control.
- Inner loop of lateral channel completes roll attitude control.

# S40/S50 flight control & navigation system

## 5.2.3 Mission payload control

S40/S50 provides one-circuit mission payload control signal (DO1), multiplexed for control of both photographing and nacelle switch.

Mission payload channel supports GCS40 remote control and automatic implementation of route planning mission.

In automatic mode, when S40/S50 fly in the preset route, the mission formulated at certain waypoint in the route will be executed upon arrival and maintained till the next waypoint, then execute the mission at the next waypoint.



**Tips:** S40/S50 will not execute any mission when in circling route or homing route and the mission channel maintains the original status without any action.

# Overview of GCS40

## 6. The Usage of GCS40

### 6.1 GCS40 Installation

Operating environment: WinXP, Win7, Win10

Hardware support: Conventional PC, internally installed or extensible asynchronous serial communication port (RS232) or Ethernet card.



Tips: in serial port mode, GCS40 shall be configured with asynchronous serial communication port (RS232); in network mode, GCS40 shall be configured with Ethernet card.

### 6.2 Overview of GCS40

Main functions of GCS40: remote control and telemeter, flight instrument, status alarm, data recording, electronic map, waypoint editing, system calibration, parameter configuration, etc.

The main interface of GCS40 is shown in Fig. 6.21 and 6.22

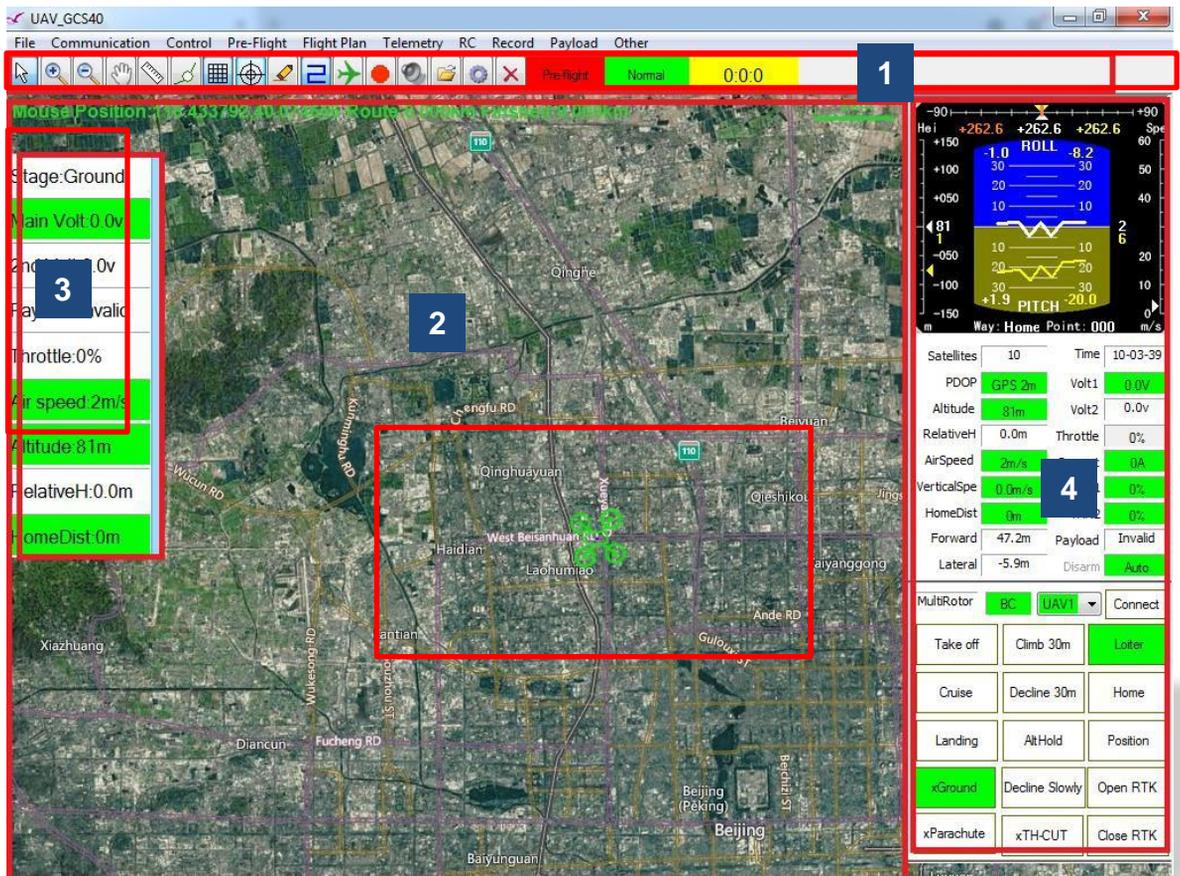


Fig.6.2.1 Main interface of GCS40

1. Quick access tool column,
2. Electronic map zone,
3. Key parameter zone,
4. Key command zone

# Overview of GCS40

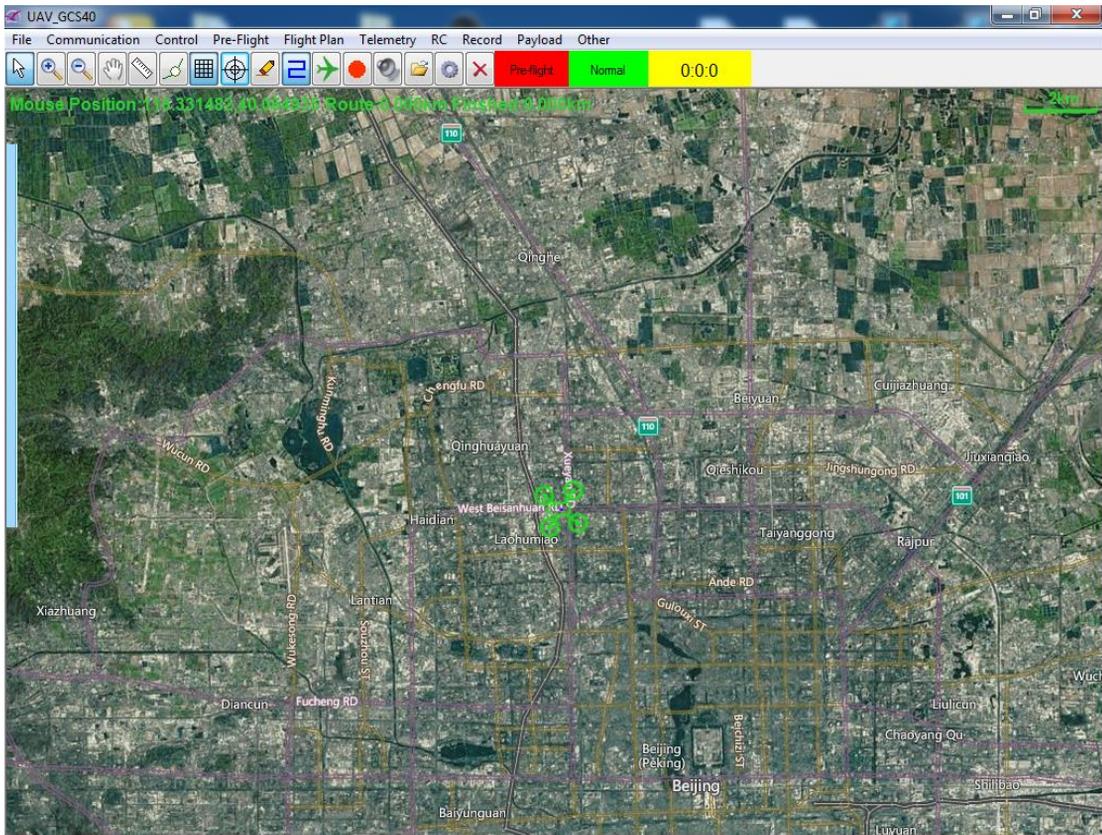


Fig. 6.22 Main interface of GCS40 (hide key parameter zone, key command zone and flight instrument zone)



**Tips:** the key parameter zone, key command zone and flight instrument zone of GCS40 can select hide/display (click the “V” or “Λ” on the upper side of such zone) mode to provide more space for the electronic map zone.

# Overview of GCS40

## 6.3. Electronic map zone

Electronic map can select MAPX map, photo map or online map, online map by default.

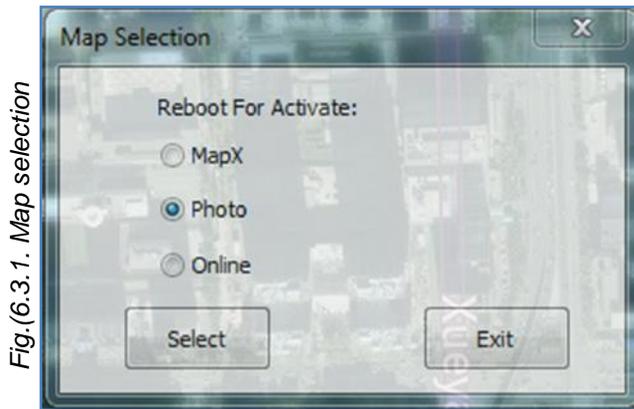


Fig.(6.3.1. Map selection

Fig 6.3.2. Map selection



The electronic map zone is shown in Fig 6.2.

The electronic map zone has five layers, including map layer, grid layer, route layer, path layer and aircraft layer.

**Map layer:** select images of JPG/BMP/GIF format as the background map, and coordinates the picture by operating the map registration. Any pixel on the picture corresponds to the unique latitude and longitude coordinates. The map can be enlarged, shrunken and moved. The map layer without a background map is white.

**Grid layer:** distances between vertical gridlines and lateral gridlines are all 1000m. When the map is zoomed out, gridlines will disappear automatically because they are too intensive. The gridline is grey and can be hidden.

**Route layer:** route layer can conduct waypoint editing and route display. The route line is red.

**Track layer:** track layer indicates the flight track of the aircraft. Track will be automatically eliminated when it is too long. The flight track is blue and be hidden.

**Aircraft layer:** aircraft layer can dynamically display the position (longitude and latitude) and nose direction of the aircraft. The aircraft icon switches in accordance with the fixed wing/multi-rotor mode.

## 6.4. Quick Access Toolbar

From left to right, the definitions of the quick access toolbar are: select tools, zoom in map, zoom out map, move map, distance measure, edit waypoint, display grid, find aircraft, clear track, display track, record local data, alarm sound, open map, configure map, cancel map; the rightmost includes preflight inspection, system status lamp and duration display.



Fig.6.4.1 Quick access toolbar

- 
**Distance measure:** select this tool to measure the distance between any two points (through mouse click) in the electronic map zone.
- 
**Waypoint editing:** select this tool, double click the left button in the electronic map zone to add this point in the flight route.
- 
**Display grid:** select this tool, the electronic map zone will automatically display the grid lines. When the selection is cancelled, the grid lines are hidden. The distances between both vertical gridlines and lateral gridlines are all 1,000m. This function is only applicable to image map mode.
- 
**Find aircraft:** click the button, current position of the aircraft will automatically become the center of the electronic map zone, so that the aircraft can be found when it flies beyond the interface displaying range.
- 
**Clear flight track:** click this button to clear all the recording track if the track display in the electronic map zone is in disorder.
- 
**Display flight track:** select the tool, the electronic map area automatically displays the track line, deselect the track line hidden
- 
**Record local data:** select this tool, GCS40 will automatically generate recording files in the Record folder under the installation directory. All the telemetering information of S40 will be recorded in such file. The button turns green when the recording begins. After the aircraft takes off, GCS40 will automatically activate the local data recording.
- 
**Alarm sound:** select the tool, if any abnormal status inner the telemetering information of S40, GCS40 will continue rings the alarm sound until the abnormal condition disappears. Cancel the selection, even there is any abnormal condition inner the telemetering information of S40, GCS40 will not trigger the alarm sound.
- 
**Open map:** when flying in different regions, user can select different images or offline
- 
**Configure map:** in photo map mode, the new photo will be effective background map after being registered. Input the latitude and longitude coordinates at the upper left corner and lower right corner of the picture, GCS40 will establish planar coordinate system for such photo

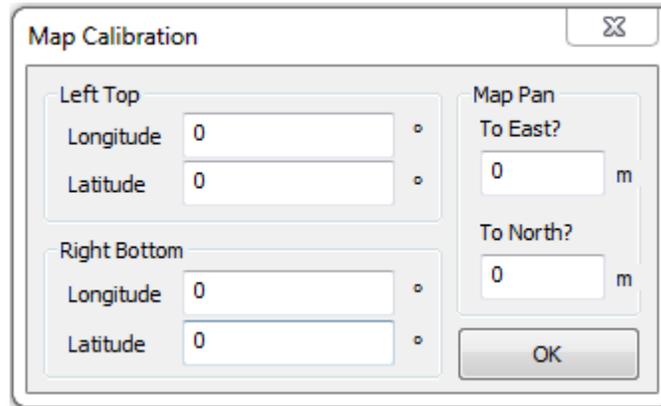


Fig. 6.4.2 Map configuration interface under photo map mode

When under the online map mode, map source, positioning, map downloading and error compensation can be selected.

**Map:** Bing Hybrid Map and Serve And Cache are selected by default.

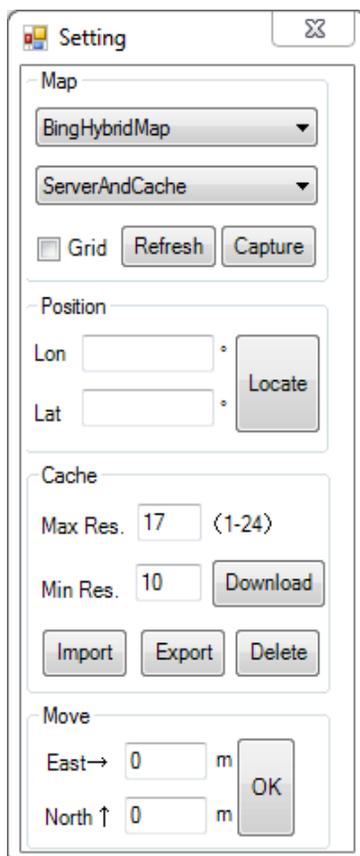
**Positioning:** input the longitude and latitude (in degree) of the target position and click “Positioning”, and then the target position will automatically move to the center of the electronic map area;

**Caching:** download the map of selected area (press ALT to select the download area), or import downloaded or other electronic map, or export the current map;

**Map planning:** when the electronic map is inaccurate, error compensation can be achieved by inputting the amount of map translation.

**Map cancel:** if users do not have proper flight regional map, the background map can be cancelled. At this time, the background of the electronic map zone is white. This function is only applicable to image map mode.

Fig. 6.4.3. Map registration interface under online map mode



**Pre-flight check:** click to enter the interface of preflight inspection process, red color indicates the preflight inspection is uncompleted; green color indicates the preflight inspection is completed. When the preflight inspection is uncompleted, the “Take off” command can not be operated.

**System alarm:** click to enter the complete telemetry interface, red color indicates the system status is abnormal; green color indicates normal. When system alarm rings, “Take-off” command can not be operated.

**0:0:0** statistics of flight duration: time will be automatically accumulated after take-off of the UAV, the ground segment is not included; after switched from the ground segment to “take of” light duration will be cleared.



**Tips:** after selecting the quick access of “Waypoint Editing”, double click the left button of the mouse in electronic map zone to add this point to the route.  
Hold the “Shift” key and double click the left button in electronic map zone, the newly added point will automatically orthogonal to previous waypoint.  
Move the mouse to the added waypoint, hold the left button to drag the point.



**Tips:** the local record files in GCS40, whose format is compatible with Microsoft office, can be directly used to analyze the flight data. GCS40 can also use the record files for flight data replay.



**Tips:** under the image map mode, the source of background map can be satellite image, digital map, aerial photo, etc.; the background map is compatible with three image formats: JPG, BMP and GIF.



**Note:** the newly added map images will be effective background map after being registered, otherwise the coordinate system is in disorder.



**Note:** if the preflight inspection is uncompleted or there is a system alarm, the “Take off” command cannot be given.

## 6.5. Key parameter zone

Fig. 6.5.1/ Key parameter zone of fixed wing mode



Fig.6.5.2. Key parameter zone in multi-rotor mode



The key parameter zones are as shown in Fig. 6.5.1 and 6.5.2 and the specific definitions are as follows :

**Satellites:** The box displays the number of GPS satellites searched, in units.

**PDOP:** GPS positioning accuracy. When low positioning accuracy, the control turns red; when the positioning is normal, the control turns green.

**Altitude:** the integration of GPS height and pressure height. The height below sea level is negative. The height control is provided with status alarm function, it turns red when the height is too high or too low and turns green when the attitude is normal.

## Key parameter zone

**Relative Height:** the altitude of aircraft relative to the ground.

**Vertical Speed:** skyward speed; upward is positive and downward is negative. When the negative value of elevating speed is too large, the control widget turns red, and becomes green when the speed is normal.

**Target distance :** in the fixed-wing mode, the distance from the aircraft to the current target waypoint.

**Home distance:** the distance from the aircraft to “Home”. The default “Home” position is the point where the aircraft switches from manual mode to autonomous mode, which can also be set via GCS40 (edit “Home route”). Home distance also provides the function of status alarm. When the distance exceeds the threshold level, the control widget turns red, and becomes green when it is normal.

**Offset:** Under the fixed-wing mode, the vertical distance from aircraft position to the current flight section. It is positive when the aircraft flies on the right of the route and negative when flies on the left.

**Forward:** under the multi-rotor mode, component of the distance from the aircraft to the current target waypoint on the vertical axis of the aircraft, and the number is positive when the target point is in the front .

**Lateral:** under the multi-rotor mode, component of the distance from the aircraft to the current target waypoint on the lateral axis of the aircraft, and the number is positive when the target point is on the right.

**Time:** Beijing time.

**Volt:** S40/S50 provides 2-circuit analog channels; 2-circuit voltage or 1-circuit voltage+1-circuit voltage can be selected. When monitoring 2-circuit voltage, the ADC2 channel will be displayed in multi-rotor mode and the ADC1 channel will be displayed in the fixed-wing mode, as shown in Table 2.1. When the voltage is normal, the control widget is green and when the voltage is lower than the threshold level, the control widget turns red.

**Fuel:** for oil-fueled engine, S40/S50 can estimate the remaining fuel. When the fuel mass is normal, the control widget is green and it turns red when the fuel mass is below the threshold level.

**Current:** S40/S50 is capable of monitoring current through the dedicate current measuring module for external connection. When the current is normal, the control widget is green; and it turns red when the current is below the threshold level.

**THR:** for oil-fueled engine, S40/S50 can monitor the 2-circuit engine speed in revolutions per minute (RPM). When the speed is normal, the control widget is green; and it turns red when the speed is below the threshold level.

## Key parameter zone

**Throttle:** for electro-motor, S40/S50 can monitor the throttles of fixed-wing and multi-rotor.

**Lock:** display the lock/unlock status of the remote controller. When exceeding the remote control distance of RC remote controller, the display fades out.

**Mode:** display the current control mode, including manual, semi-autonomous and full-auto. When S40/S50 works in the protection mode, the control widget is red; when S40/S50 works in the calibration mode, the control widget is blue; when S40/S50 works in normal mode, the control widget is green.

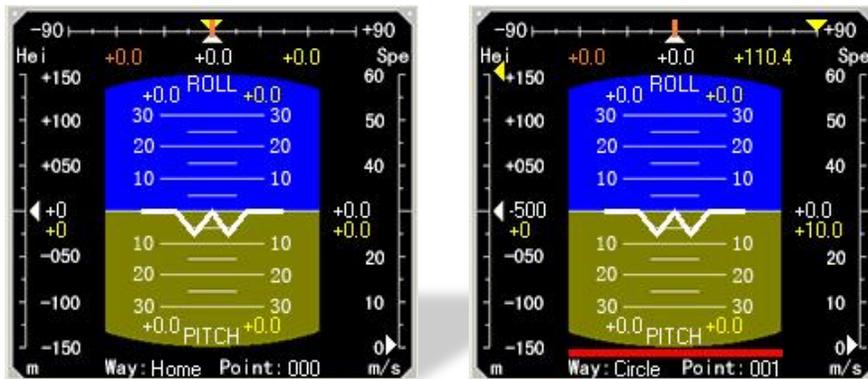


**Notes:** the alarm threshold of key parameters zone can be set in the Flight preparation in the function menu bar →interface of protection configuration.



**Notes:** when ground preparation is completed and the aircraft is in the state to be fly, all status in the key parameter zone should be normal and in green. When other colors (blue or red) are present, please carefully check the system, otherwise security risks may be caused.

## 6.6. Flight Instrument Zone



A

Fig. 6.6.1 Flight instruments

B

The Flight instrument zone is shown in Fig. 6.6.1, in which the upper part is the course display zone, the left part is the height display zone, the right part is the speed display zone, the bottom part is the route display zone and the middle part is the attitude display zone. The course and attitude values are in units of degree.

In Fig. 6.6.1, the display in white is the current value, and the display in yellow is the target value. In the course display zone, the value in red on the left indicates the current flight track, the value in white in the middle indicates the current nose heading direction and the value in yellow on the right indicates the target course.

The Way in the route display zone indicates the current route, and Point indicates the current In the upper part of the attitude display zone, ROLL indicates the current rolling, and PITCH indicates the current pitching.

**⚠ Notes:** if the course and attitude sensor of S40/S50 are abnormal, there is a red alarming bar at the bottom of the attitude display zone as shown in Fig. 6.6.1 (B), indicating there is a serious threat to flight safety!

## 6.7. Key Command Zone

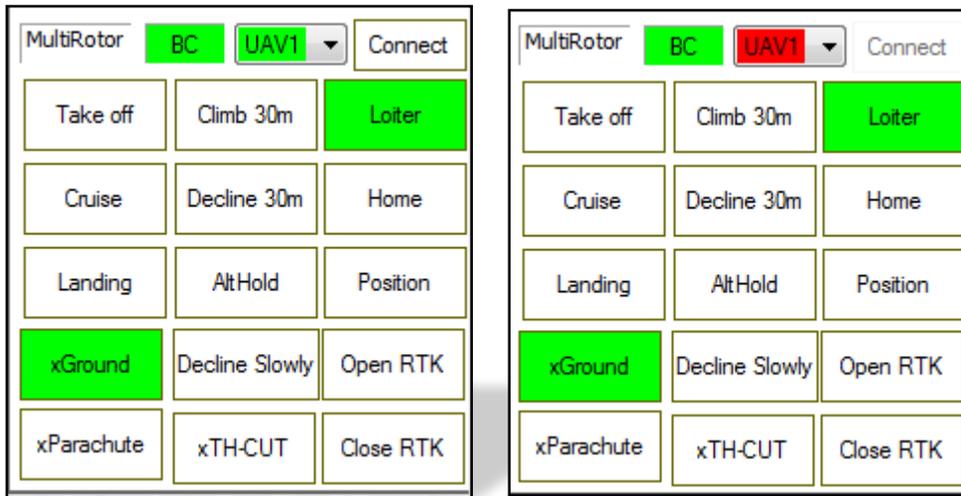


Fig.6.7.1. Key command

In key command zone, “Ground segment/ Takeoff segment/Cruise segment/Landing segment”, “Altitude setting”, “Position fine-adjustment”, “Circle/Loiter/Home”, “Parachute opening”, “Stop” are effective by double clicking to prevent mis-operation. Buttons in green indicate the current state of S40.

**Aircraft selection:** S40/S50 system supports multi-station and multi-aircraft.

Three ground stations (GCS40) and three aircrafts (S40) can coexist in a network at the same time, while one ground station can only communicate with one aircraft, and select the aircraft required to communicate with through the aircraft selection box (the option in the aircraft selection box should be in accordance with the ID of the current airborne S40/S50).

After the aircraft is selected, the operation commands are only valid for the aircraft with corresponding ID.

The control widget also provides status indication of telemetry link.

When the telemetry information loses frame, the control widget becomes red; when it returns to normal, it will become green.

GCS40 will automatically save the items selected by the aircraft. UAV1 will be selected by default.

## Key Command Zone

**Connect:** When the local communication configuration is normal, the “Connect” button is valid, otherwise, the “Connect” button is not operational, the user need to go to the “Communication” menu to configure the communication of the aircraft.

When the system is normal, click “Connect” button and S40 will periodically send telemetry data packages to GCS40, at the same time “Connect” switches to “Disconnect”.

Click again, S60/S70 stops sending telemetry data packages to GCS40m and then “Disconnect” switches to “Connect”.

The sending frequency of telemetry package is modulated through the pop-up interface of telemetry→ frame frequency→ telemetry frame frequency setting in the function menu bar.

**Command status:** when S40/S50 is capable of normally respond to the command given by GCS40, the command status turns green, otherwise it turns red.

If GCS40 does not receive corresponding command responded by S40/S50 within three seconds, the command status is deemed to be abnormal and it will turn red.

**Alt Hold:** maintain the current flight altitude in the current flight segment until the aircraft switches to a new waypoint.

**Position:** effective only for the multi-rotor mode, finely tuned the altitude, horizontal position and course heading.

Double click the symbol “▲” in the middle to drag the literal position of the aircraft.

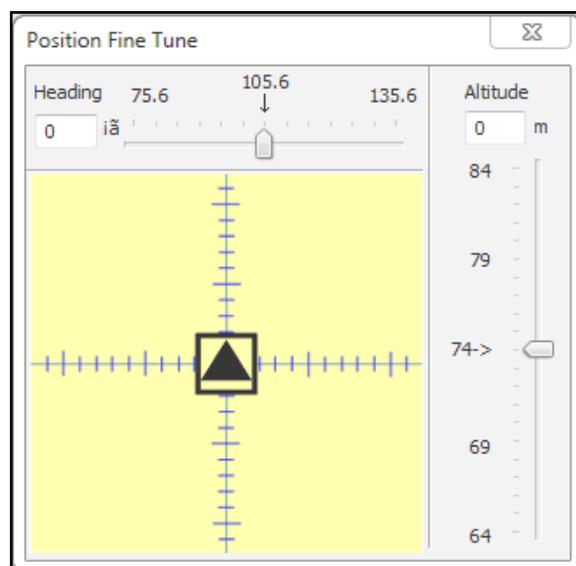


Fig. 6.7.2. Position fine tune

## Key Command Zone

**Circle:** the aircraft will execute the circling route centering the current position, and the circling radius is the system factory default setting.

**Home:** the aircraft will execute the homing (return) route, as shown in Section 4.3 for details.

**Ground:** the aircraft enters ground waiting phase, the motor stalls and the fuel engine idles.

### The command belongs to high-risk command!

**Take off:** the aircraft executes takeoff command; after entering the takeoff phase, the aircraft will automatically switch to multi-rotor mode and unlock. The takeoff command is only effective in full-auto mode, normal GPS positioning, non-calibration status and non-protection status.

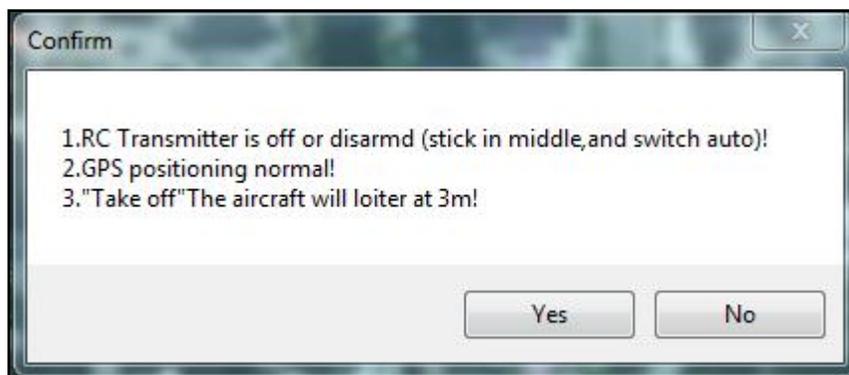


Fig. 6.7.3 Confirmation of takeoff command

**Cruise:** the aircraft vertically climbs to the height above 10m and automatically switch to the cruise phase when it reaches the desired altitude.

The cruise command is only effective in full-auto mode, normal GPS positioning, on-going multi-rotor hovering, non-calibration status and non-protection status.

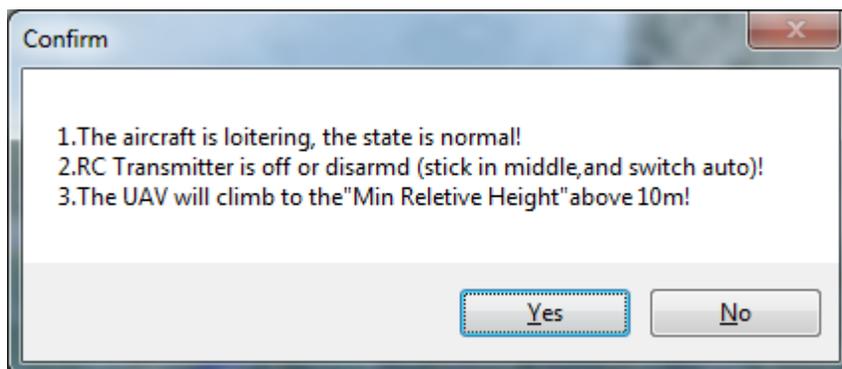


Fig.6.7.4. Confirmation of cruising command

## Key Command Zone

**Landing:** the aircraft switches to the multi-rotor mode and enter the landing process. If the aircraft is currently in the fixed-wing circling route, it will fly to the circling center for landing; otherwise, the position at which it receives the command will be the landing point.

After entering the landing phase, the aircraft first maintains current altitude, and then fly to the target point in multi-rotor mode.

When the distance is within 3m radius of the target point, the aircraft start to reduce height.

If the aircraft is currently in the landing phase, send the landing command again to carry out descending directly.



Fig. 6.7.5. Confirmation of landing command



**Notes:** Mis-operation of commands “parachute opening”, “TH-CUT” and “ground phase” brings severe safety issues; therefore, the three commands are in prohibited status (X) by default and can be activated (√) by double clicking, and commands can be sent out by double clicking again.



**Tips:** the buttons turning green in the key command zone indicates the current status of S40/S50, which are sent to the GCS40 software by telemetry data packages. Therefore, the information can only be timely updated when the “Connect” button of telemetry is operational.



**Notes:** the factory ID of S40/S50 is UAV1 and the default number of GCS40 is GCS1. The aircraft selection box boot is “UAV1” option by default, so please don’t change the ID configuration if multi-station and multi-aircraft function are not required – the default status should be remained.



**Notes:** all the operation commands from GCS40 to S40/S50 require to be judged whether the command is effective via state control widget’s color!  
When S40/S50 can normally respond the commands given by GCS40, the command status turns green, otherwise it turns red.  
If GCS40 cannot receive corresponding command send by S40/S50 within three seconds, the command status is deemed abnormal and the command turns red. Once it turns red, corresponding operations needs to be operated again.

## 6.8 Function menu bar

The layout of the function menu bar is shown in Fig 6.8.1.



Fig.6.8.1. Function menu bar

### 6.8.1 “File”

“**Map Selection**”: the type of GCS40 electronic map can be selected; online map is selected by default; MAPX map requires the installation of third-party software MAPX.

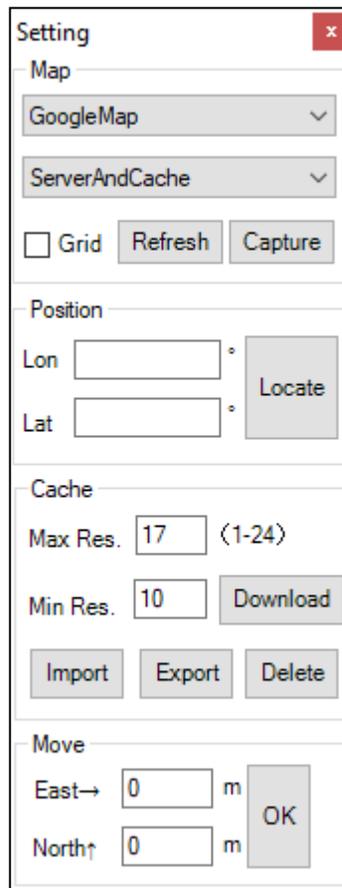


Fig. 6.8.2. Map selection

“**Import map**”: the same function as the map opening map in the express toolbar.

“**Configure map**”: the same function as the map configuration tool in the express toolbar.

“**Exit**”: close the process of GCS40 software.

### 6.8.2 “Communication”

GCS40 and S40/S50 achieve information exchange by universal asynchronous receiver/transmitter (UART) or Ethernet. Prior to “Connect”, communication configuration should be carried out on the local computer (the computer that runs GCS40) and the airborne system (S40/S50).

The S40/S50 system supports multi-station and multi-aircraft. Three ground stations (GCS40) and three aircrafts (S40/S50) can coexist in a network. Each ground station and aircraft is assigned with a unique ID which can be set by communication configuration.

**Notes:** the factory ID of S40/S50 is UAV1 and the default number of GCS40 is GCS1.

Aircraft selection box root is “UAV1” option by default. Please don’t change the ID configuration if multi-station and multi-aircraft are not required – the default status shall be remained.

#### Configurations of GCS ID, ground port and ground network.

“**GCS ID Setting**”: the main telemetry and control station are selected by default. Data packages sent by S40/S50 inconsistent with the ground number will be ignored by GCS40. Click “Confirm” and GCS40 will automatically record the ID.

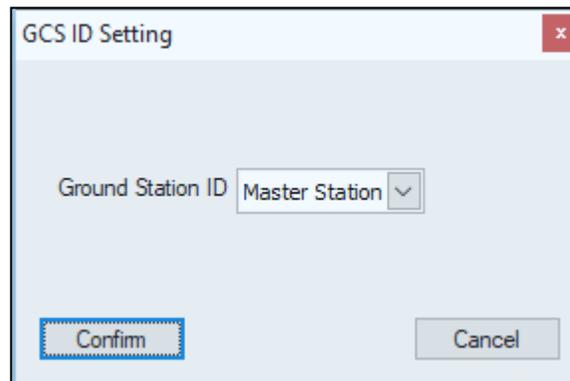


Fig. 6.8.3. GCS ID setting

**“Host port”**: configuration of ground port includes the selection of port number, Baud rate and operation mode.

The operation modes can be decided into “Serial mode” and “Network mode”, and GCS40 works in “Serial mode” by default. If the user select “Network mode”, the ground network needs to be configured.

Clicking “Confirm” button, and GCS40 will automatically records the configuration.

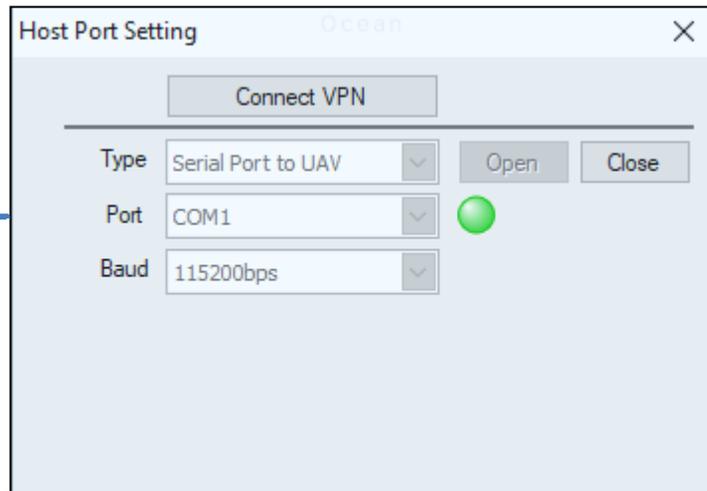


Fig. 6.8.4a. Port configuration of local computer (Serial port)

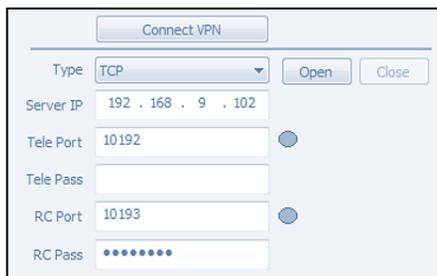


Fig. 6.8.4b. Local port configuration, network (TCP) mode

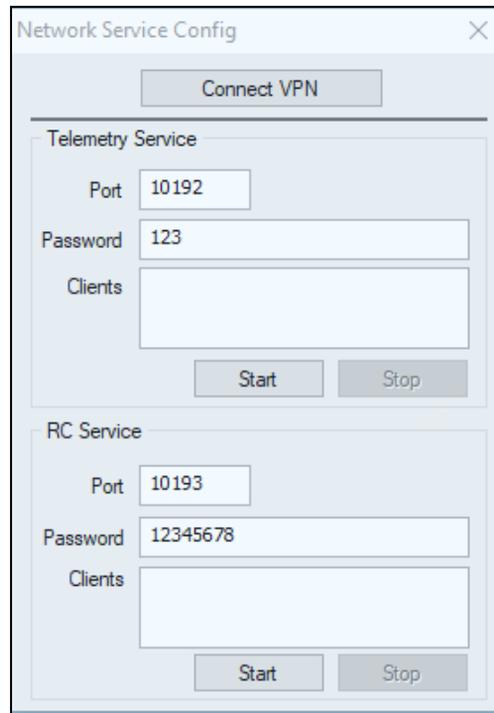


**Tips:** in “Serial mode”, GCS40 and S40/S50 exchange information directly by universal asynchronous receiver/transmitter (UART).

“**Ground network**” : GCS40 supports remote client which can conduct remote control and telemetry of aircraft via TCP protocol.

Remote control and telemetry network services can be operated separately and set the service password respectively to ensure the safety of remote operation.

**Notes:** if the remote client is just watching, the telemetry service can be operated only; if the remote control service is activated, the remote client can send all the remote control commands, processing the same permission as the local GCS, please be careful!

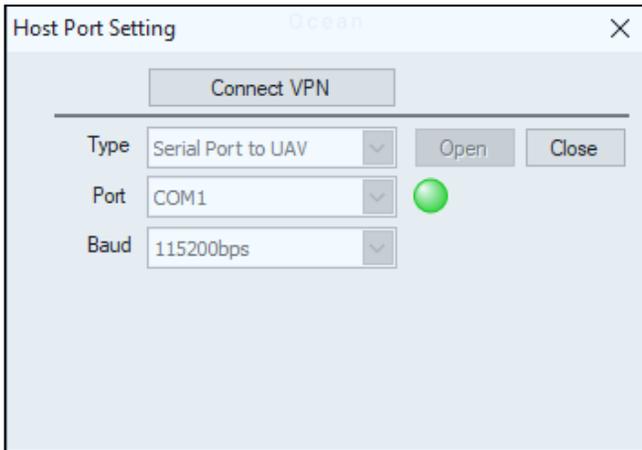


*Fig. 6.8.5. Local machine enabling Network setting*

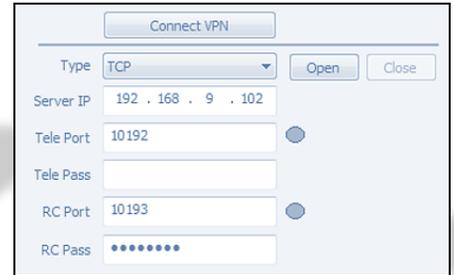
**Notes:** If any network port ID conflicts with other processes of the aircraft, it shall be changed, otherwise GCS40 ca not work normally!

**Tips:** example of “Network Mode”: The IP address of the GCS40 (server) directly connected to the flight control is 192.168.1.1.

The communication configuration of the server is shown in Fig. 6.8.7 and that of the remote monitoring host is shown in Fig. 6.8.8.



*Fig. 6.8.7 Communication configuration of server, enable remote control and telemetry network service*



*Fig. 6.8.8 Communication configuration of remote monitoring the host*

## “Configuration of Airborne communication parameter”

Airborne communication parameters are specific for S40/S50 which is configured through GCS40 and parameters are saved in S40/S50.

The operation of “Read” is a broadcast instruction which is effective for all numbered aircrafts.

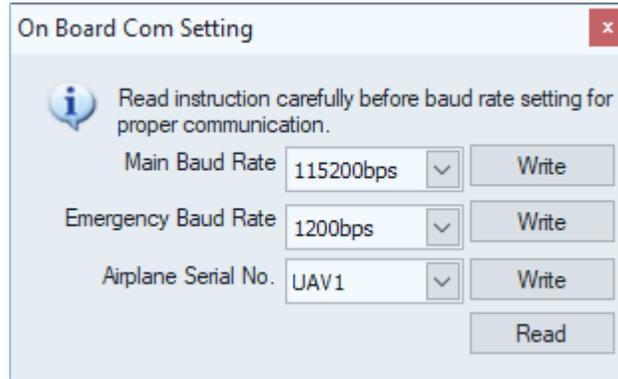


Fig.6.8.9 Airborne communication parameter configuration



**Tips:** if the demand of the hardware communication link on the communication Baud rate changes, the Baud rate of the local machine and the airborne Baud rate need to be changed accordingly.



**Notes:** the airborne Baud rate will be sent to S40/S50 after changes and “Write” have been made, and they will become valid after being processed at S40/S50. Meanwhile, it is necessary to change the local Baud rate of GCS40 correspondingly to re-establish the connection; otherwise the system may not work properly! The “Write” of aircraft number will become valid immediately.

**Notes:** if the hardware is connected properly, but GCS40 cannot establish normal communication with S40, the number of the local port in CS400 may be chosen incorrectly, or the airborne Baud rate of S40 is inconsistent with that of the CS400 host, or the aircraft ID for S40 is inconsistent with the option of the aircraft for GCS40.

In that case, the following steps should be taken:

**1 First to confirm whether the local port number is selected correctly.**

Open the Device Manager in the Windows System Properties to check the potential local ports, as shown in Fig. 6.8.10.

Open Windows Hyper Terminal or other software of serial port tools to select a potential port number.

Configure the Baud rate at 9,600 bps, then electrify S40, if data can be received (messy code or valid ASCII code are shown as Fig. 6.8.11 at this time, the port number is selected correctly).

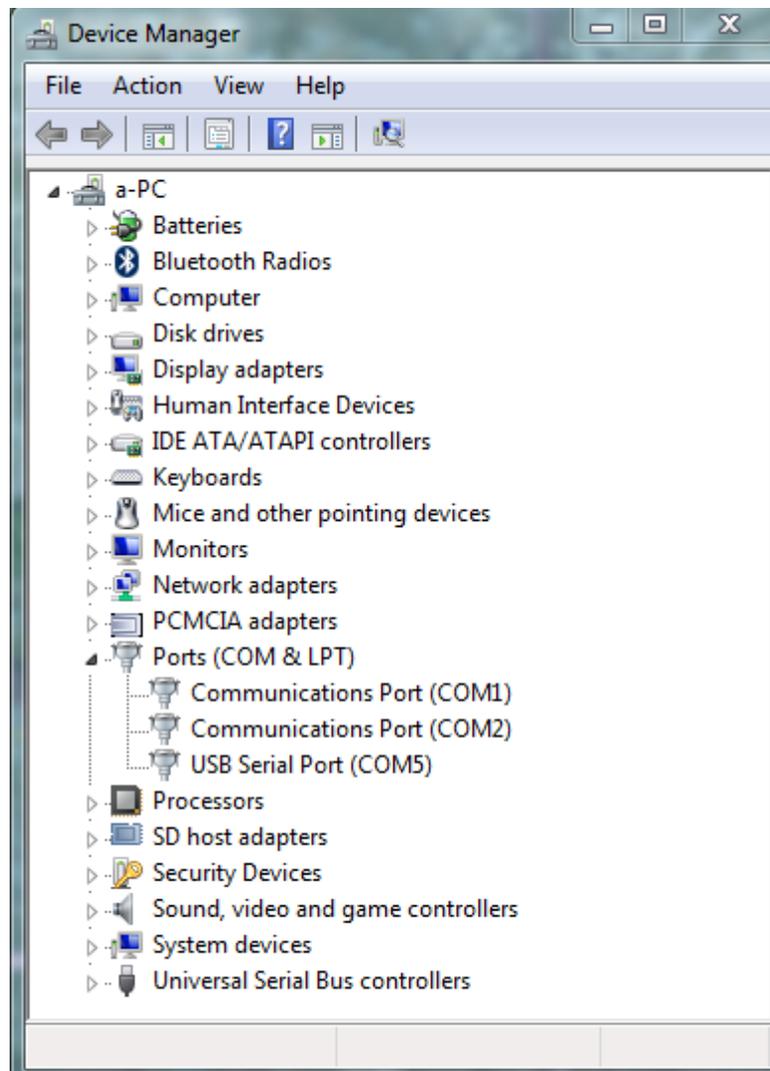


Fig. 6.8.10 Check the port number

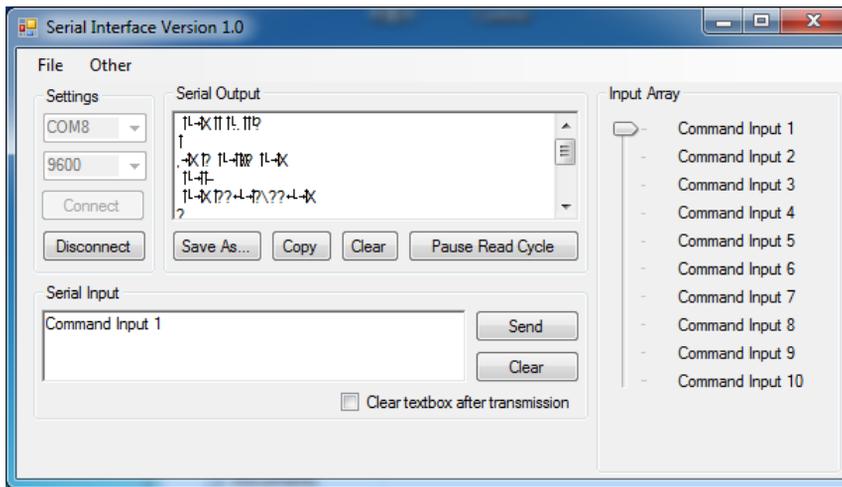


Fig. 6.8.11. Serial port receiving messy code

## 2 Confirm the consistency of the Baud rates

Open the Windows Hyper Terminal or other serial port tools to select the correct port number, and choose the Baud rates successively among the selections of 1,200, 2,400, 4,800, 9,600, 19,200, 38,400, 57,600, and 115,200.

Power on S40/S50 after each selection is “OK”.

If the data received is valid ASCII codes (displaying words as S40/S50 Flight Control System!) at a certain time, then the option of the Baud rate is correct;

## 3 Configure the communications for GCS40 in accordance with correct port number and Baud rate.

Configuration of GCS40 communication→ Local configuration→ Local port option. After the configuration becomes normal, power on S40/S50, then the color of command status in key command zone changes;

## 4 Check the aircraft ID

The operation of “Check” of the airborne communication parameter is a broadcast instruction which is valid for all numbered aircrafts.

The check result directly updates in the aircraft ID column, and then the option of the aircraft selection column in the main interface is changed to be the aircraft ID.

## 5 Now GCS40 and S40/S50 can establish normal “connection” of communication

### 6.8.3 “Control”

The “Control” menu includes pop-up interfaces of the throttle level calibration, other servo calibration, magnetic heading calibration, installation calibration, longitudinal control laws, heading course control laws, rolling control laws, speed control laws, RC sensitivity setting, reset to factory default, factory default 1, factory default 2, channel configuration, hardware status, etc.

The user can adjust the flight control parameter of S40 through these interfaces (as shown in Section 5.2 for details), and can restore to factory default parameter of S40/S50 when necessary.

**Notes:** In order to avoid flight risks caused by errors of parameter adjustments, pop-up interfaces including the installation calibration, longitudinal control laws, heading control laws, rolling control laws, speed control laws, factory default 1 and factory default 2 of GCS40 are generally not available for users!

For details on the adjustment of control parameters, please refer to the technical documents provided by the manufacturer.

**Notes:** when GCS40 enters the calibration mode, the “mode” controller of the key parameter zone in the main interface turns blue.

#### Throttle lever calibration

Specific details are shown in Section 3.2.

#### Other servos calibration

Specific details are shown in Section 3.2

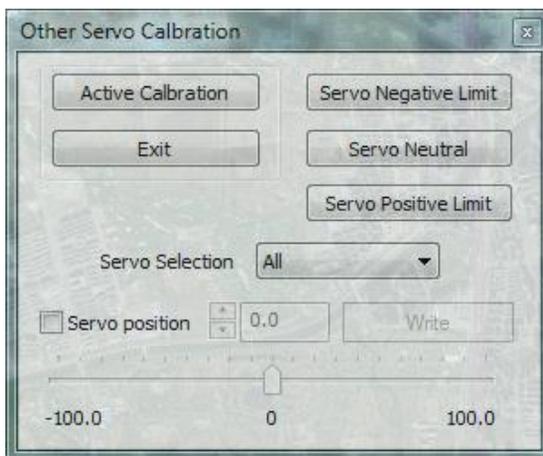


Fig.6.8.13. Other servo calibration



Fig. 6.8.12. Throttle lever calibration

**Tips:** S40/S50 automatically enters the calibration mode after the throttle lever calibration or other servo calibrations, meanwhile the “mode” controller in the status alarm bar of the GCS40 main interface turns blue.

**Notes:** all the operation commands from GCS40 to S40/S50 are required to be checked by the color of the command status controller to determine effective or not! If the controller turns red, then corresponding operation is invalid and needs to be re-executed!

## Magnetic heading calibration

S40/S50 internally integrates the magnetic heading direction sensor, and needs magnetic heading calibration based on the magnetic interfering situation on the spot. Enter the magnetic heading calibration mode via the GCS40. The S40/S50 telemetry display is in calibration mode (blue), turn the aircraft until the “Calibration successful” prompt appears, and exit the calibration. If “Calibration failed”, you can re-enter the calibration.

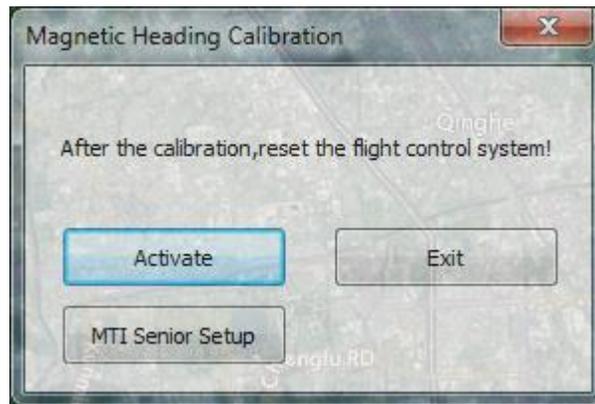


Fig. 6.8.14(a) Enter magnetic heading calibration

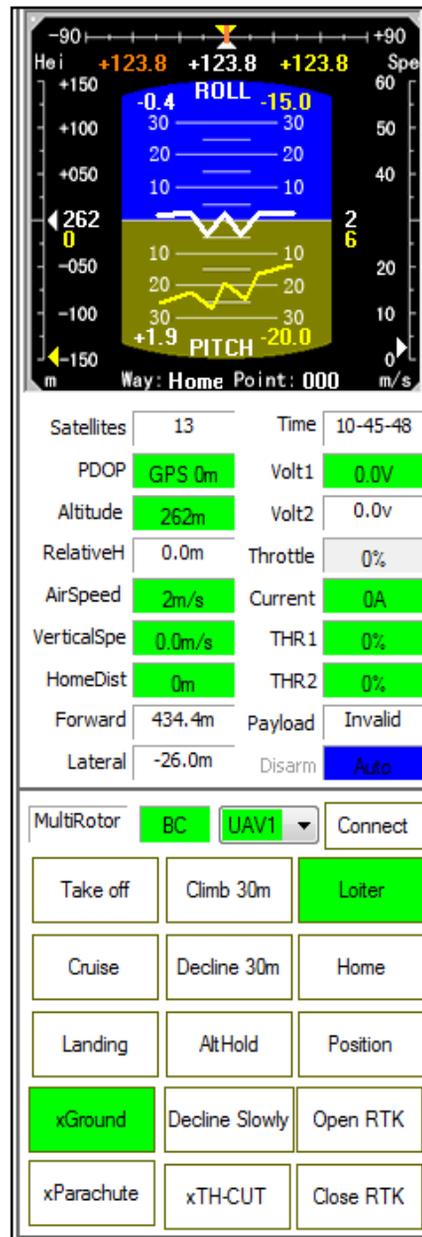


Fig. 6.8.14(b) S40/S50 in calibration mode

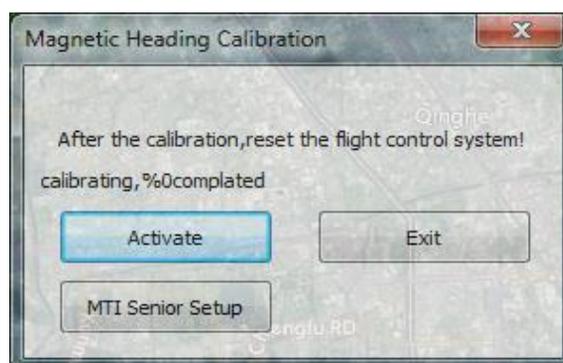


Fig 6.8.14(c) Magnetic heading calibration, start

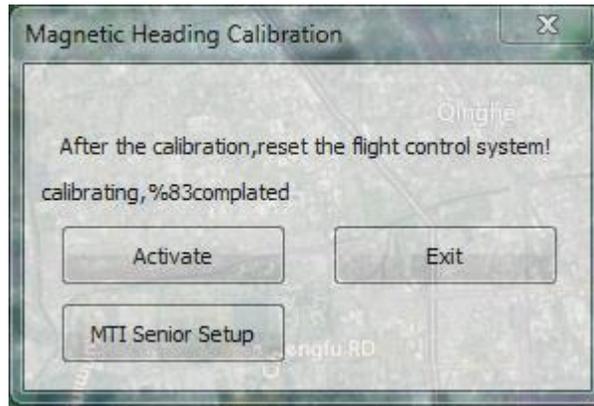


Fig. 6.8.14 (d) Magnetic heading calibration, on-going

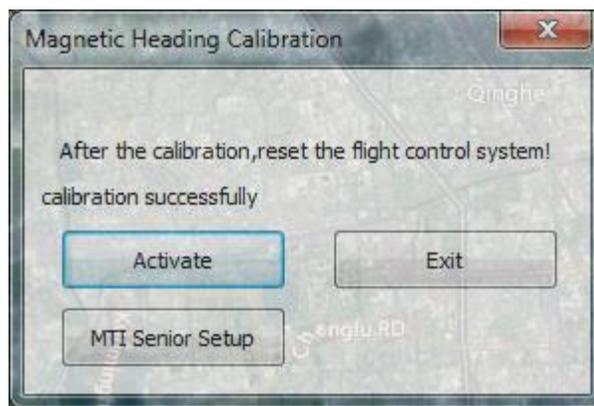


Fig. 6.8.14 (e) Magnetic heading calibration, exit

**Notes:** during magnetic heading calibration, drag the aircraft on the original spot to turn for 1~4 rounds during which the aircraft attitude (pitch, roll) shall be changed as much as possible to make the aircraft fully induce the magnetic field intensity so as to improve calibration accuracy!



**Skills:** the simplified operation of the geomagnetic heading calibration can turn the nose azimuth 45°, and then the aircraft will slowly bow, look up, left roll and right roll one time, with the motion angle range > 30°.



**Prohibited:** during the magnetic heading calibration, keep away from ferromagnetic objects around, e.g. vehicles, transformers, iron towers, large metal equipment, otherwise calibration may fail and affect flight safety!



**Notes:** after the magnetic heading calibration is completed, current nose direction (value in white in the middle) shown in the S40/S50 instrument zone shall be the same as the actual heading course (deviation less than 10°); recalibration is required when the deviation of the magnetic heading exceeds 30°.

## Control law adjustment

For GCS40, control law (pitch control laws, heading control laws, rolling control laws, speed control laws) adjustment interfaces are generally not available for users.

Please refer to the Section 5.2 if adjustment is required.

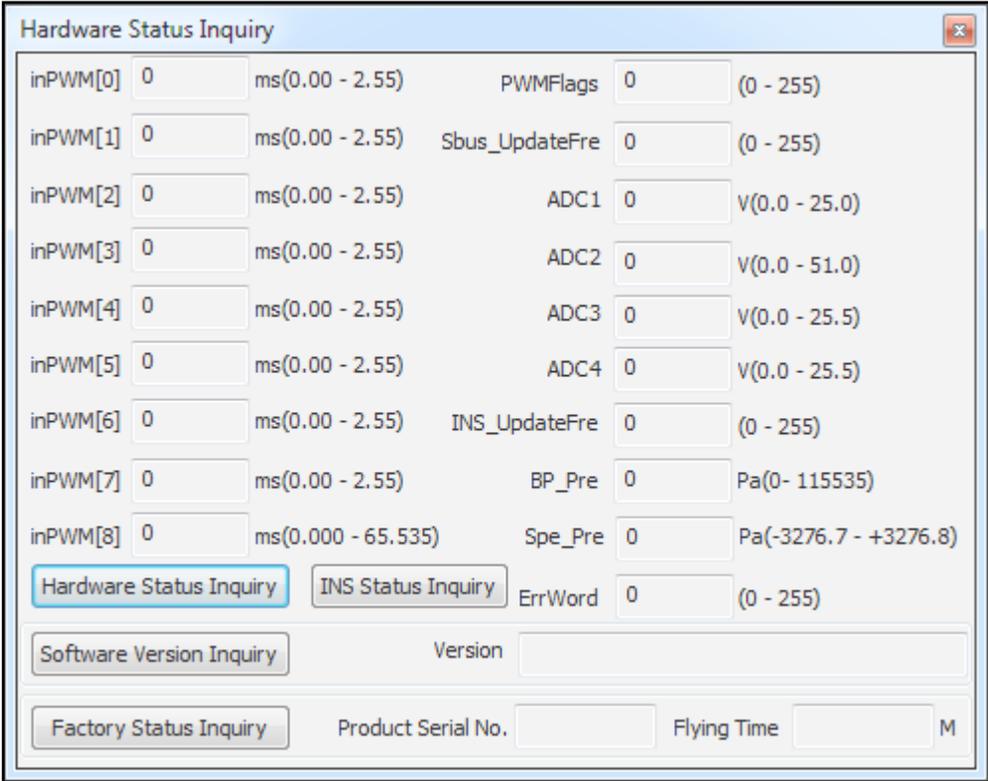
## Restore to factory default

If the parameters have been adjusted inappropriately, double click the button of “Restore to factory default”, then all control law parameters, calibration data, communication parameters and protection configuration of S40/S50 will be restored to factory default settings.

## Check hardware status

The interface for the hardware status inquiry is shown in Fig. 6.8.15.

Working data of S40/S50 hardware can be checked through this interface.



The screenshot shows a window titled "Hardware Status Inquiry" with a close button in the top right corner. The window contains a grid of parameters, each with a text input field, a unit, and a range. The parameters are:

inPWM[0]	<input type="text" value="0"/>	ms(0.00 - 2.55)	PWMFlags	<input type="text" value="0"/>	(0 - 255)	
inPWM[1]	<input type="text" value="0"/>	ms(0.00 - 2.55)	Sbus_UpdateFre	<input type="text" value="0"/>	(0 - 255)	
inPWM[2]	<input type="text" value="0"/>	ms(0.00 - 2.55)	ADC1	<input type="text" value="0"/>	V(0.0 - 25.0)	
inPWM[3]	<input type="text" value="0"/>	ms(0.00 - 2.55)	ADC2	<input type="text" value="0"/>	V(0.0 - 51.0)	
inPWM[4]	<input type="text" value="0"/>	ms(0.00 - 2.55)	ADC3	<input type="text" value="0"/>	V(0.0 - 25.5)	
inPWM[5]	<input type="text" value="0"/>	ms(0.00 - 2.55)	ADC4	<input type="text" value="0"/>	V(0.0 - 25.5)	
inPWM[6]	<input type="text" value="0"/>	ms(0.00 - 2.55)	INS_UpdateFre	<input type="text" value="0"/>	(0 - 255)	
inPWM[7]	<input type="text" value="0"/>	ms(0.00 - 2.55)	BP_Pre	<input type="text" value="0"/>	Pa(0- 115535)	
inPWM[8]	<input type="text" value="0"/>	ms(0.000 - 65.535)	Spe_Pre	<input type="text" value="0"/>	Pa(-3276.7 - +3276.8)	
<input type="button" value="Hardware Status Inquiry"/>		<input type="button" value="INS Status Inquiry"/>		ErrWord	<input type="text" value="0"/>	(0 - 255)
<input type="button" value="Software Version Inquiry"/>		Version		<input type="text"/>		
<input type="button" value="Factory Status Inquiry"/>		Product Serial No.	<input type="text"/>	Flying Time	<input type="text"/>	M

Fig. 6.8.15. Check the hardware status

## Check hardware status

In PWM[0]~in PWM[8] correspond to the aileron, elevator, throttle, rudder, manual/autonomous switch, parachute opening, engine stop, aircraft mode switch and pulse width of RC remote signal of standby channels respectively.

When a certain channel is operated through the RC remote controller, the corresponding in PWM varies within 0.5~2.5ms.

Sbus\_UpdateFre represents the data update frequency of the sensor.

Sbus\_UpdateFre is 50~120 under normal conditions.

ADC1~DC4 correspond to values of the AD acquisition channels inside S40/S50.

The variability of any AD acquisition value of all channels shall be less than 0.1V; ADC3 shall be within 4.8~5.2V and ADC4 shall be the same as the servo voltage.

MTI\_Update Fre represents the data update frequency of the sensor, and is about 200 under normal conditions.

BP\_Pre corresponds to the atmospheric pressure, which is about 1 ATM (101,000Pa) on the ground.

Spe\_Pre corresponds to the differential pressure of the air speedometer, which is about zero on the ground.

ErrWord represents the hardware fault characters. Under normal conditions, Err Word=0; Err Word≠0 indicates a fault.

**Table 6.1 Hardware fault character of S40/S50**

Bit number	Content	Description	Fault character	Remarks
bit0	Flash1	0 indicates normal state; 1 indicates fault	1	If multiple faults occur at the same time, fault characters accumulate.
bit1	Flash2	0 indicates normal state; 1 indicates fault	2	
bit2	Internal VCC5	0 indicates normal state; 1 indicates fault	4	
bit3	CAN	0 indicates normal state; 1 indicates fault	8	
bit4	Control parameter	0 indicates normal state; 1 indicates fault	16	
bit5	System parameter	0 indicates normal state; 1 indicates fault	32	
bit6	Route parameter	0 indicates normal state; 1 indicates fault	64	
bit7	Data record	0 indicates normal state; 1 indicates fault	128	

### 6.8.4. Pre-flight preparation

The Pre-flight preparation menu includes three pop-up interfaces: “Preflight check”, “Preflight preparation” and “Safety configuration”.

**! Notes:** enter the “Preflight check” interface firstly to operate prior to takeoff; otherwise, flight safety will be severely affected!

**! Notes:** if the preflight check is uncompleted or system alarm rings, the “Take off” command can not be send.

#### Preflight check

The complete preflight inspection procedures are included in the “Preflight check” Interface, and the user can operate step by step according to tips.

After completing “Preflight check”, there is no need to enter the pop-up interfaces of “Flight preparation” and “Protection configuration”.

Users can enter the “Preflight check” interface through the menu or the express toolbar in the main interface.

The operation records of the “Preflight check” is automatically saved in the “Check” files of the local installation directory for the convenience of users to check and register.

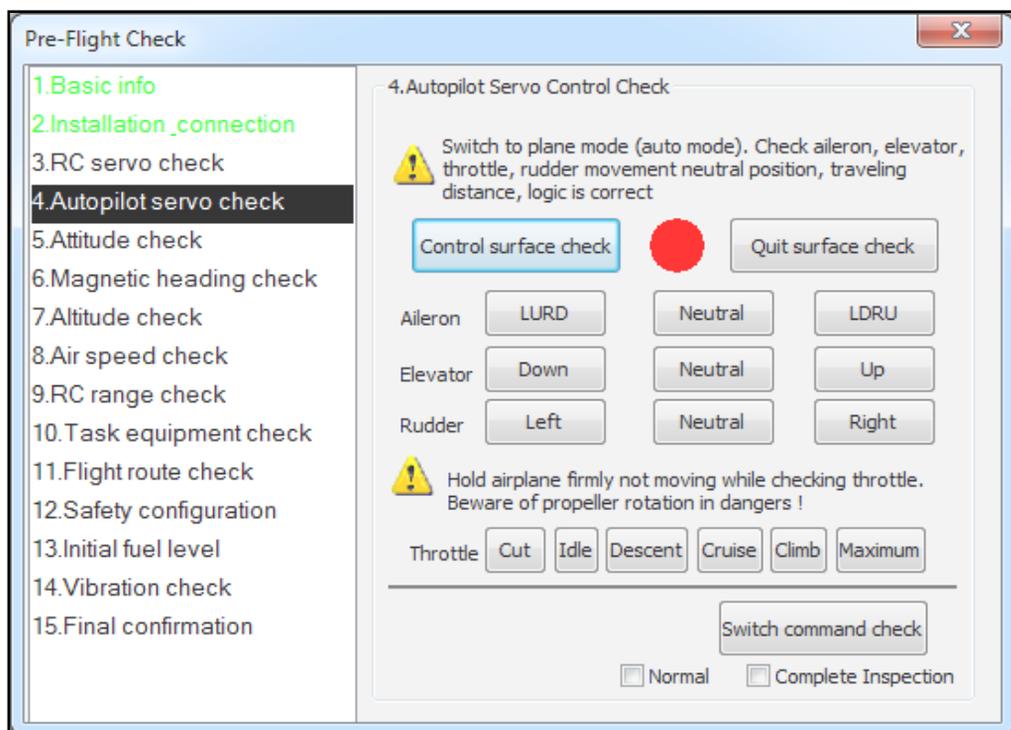


Fig. 6.8.16. Pop-up interface of preflight check

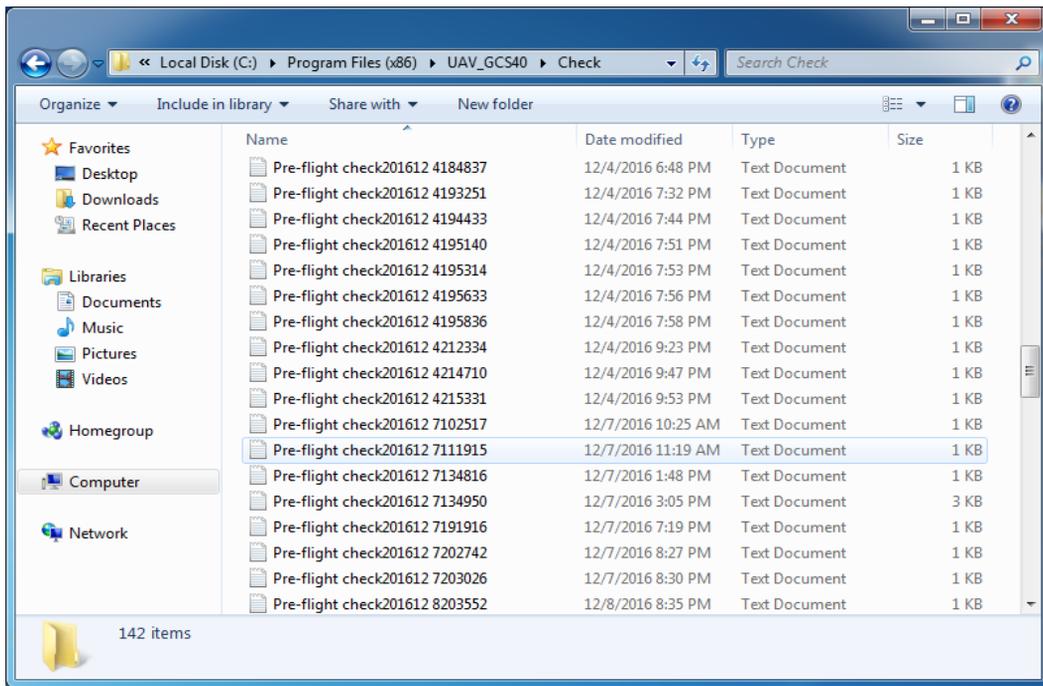


Fig. 6.8.17. Recording files of preflight check

### Pre-flight preparation

The pop-up interface of Preflight preparation is shown in Fig. (Pre-03), which is mainly designed for the setting of the flight range and initial fuel level.

The flight range shall be consistent with the corresponding content of the pop-up interface of the “Protection configuration”, while the initial fuel level shall be set according to the current fuel level.

Relevant operations of the “Flight preparation” have been included in the “Preflight check”, which are not required to be carried out alone.

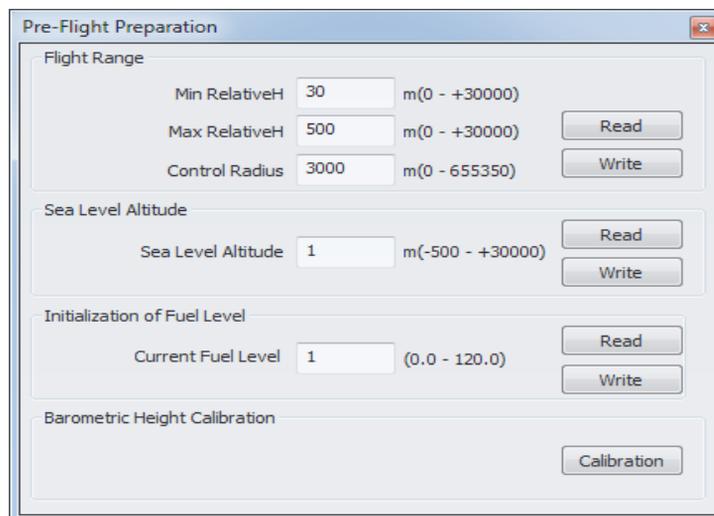


Fig. 6.8.18. Recording files of preflight check

## Protection configuration

The protection configuration interface is shown in Fig. 6.8.19.

The users shall set appropriate protection thresholds according to the actual situation of the aircraft.

If certain protection against abnormal situation is required, please select the corresponding check box (the flight attitude system failure, high altitude, low altitude, exceeding maximum flight radius and the protection system for low GPS positioning accuracy are selected automatically, users cannot cancel them).

Please refer to the Section 4.6 for details of the protection.

Relevant operations of the “Protection configuration” have been included in the “Preflight check”, and are not required to be carried out alone

**Safety Setting**

Remark : Return home voltage, Emergency land voltage should be set individually according to status of drone.

Copter Home Volt	3	V (0.0 - 100.0)	Min RelativeH	40	m (0 - 30000)
Copter Land Volt	0	V (0.0 - 100.0)	Max RelativeH	500	m (0 - 30000)
Min Current	0	A (0.0 - 120.0)	Control Radius	3000	m (0 - 655350)
Min RPM	0	RPM (0 - 20000)	Disconnect Time	120	s (0 - 655350)
Horizontal Range	300	m (0 - 2550)	Vertical Range	30	m (0 - 2550)

**Protection Selection**

Low voltage return home	<input type="checkbox"/>	GPS Low accuracy	<input checked="" type="checkbox"/>
Low voltage emergency land	<input type="checkbox"/>	Attitude malfunction	<input checked="" type="checkbox"/>
Low current	<input type="checkbox"/>	Low Altitude	<input checked="" type="checkbox"/>
Low RPM of engine	<input type="checkbox"/>	Above altitude	<input checked="" type="checkbox"/>
Hardware Fault	<input checked="" type="checkbox"/>	Exceed control radius	<input checked="" type="checkbox"/>
		Exceed safety boundary	<input checked="" type="checkbox"/>

Write Read

Fig. 6.8.19. Protection configuration

### 6.8.5 “Flight route”

Please refer to the Section 4 for details of the route.

#### Waypoint editing

Waypoint editing shall be carried out by combining the express toolbar in the main interface, electronic map zone and pop-up interface of waypoint editing. Specific details are shown in Fig. 6.8.20.

First click the express key of “Waypoint editing” in the shortcut toolbar, GCS40 will pop up the waypoint editing interface automatically; double click the left button of the mouse in the electronic map zone to add this mouse point to the route, and the newly added waypoint is shown in the waypoint list box simultaneously, with each row representing one waypoint.

Hold down the “Shift” key and double click the left button of the mouse in the electronic map zone, the newly added waypoint will be orthogonal to the previous waypoint automatically.

Move the mouse to the added waypoint, hold down the left button to drag the certain waypoint, and hold down the “Shift” key at the same time, then the waypoint can only move in the direction orthogonal to the previous waypoint.

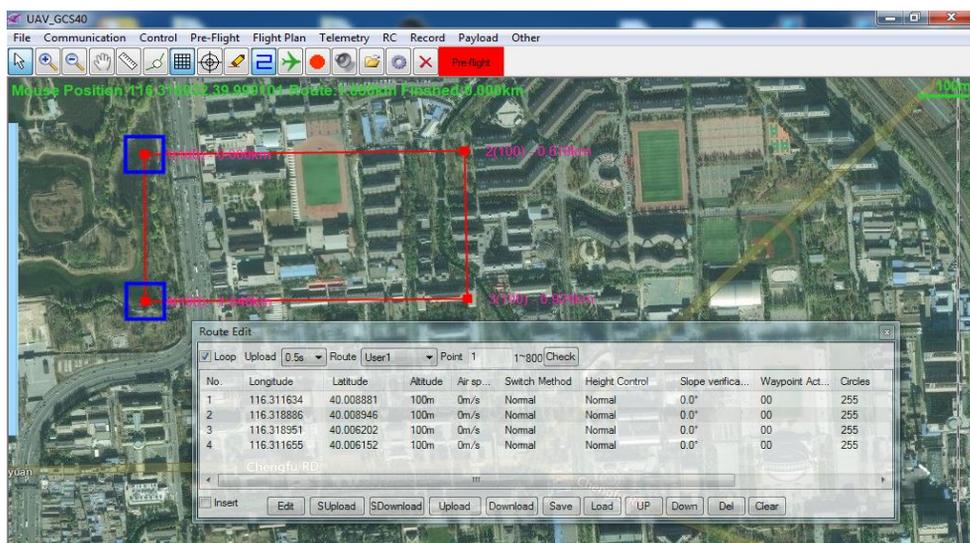
The red big block marked in the route in the electronic map zone represents the starting waypoint and ending waypoint, while the red small block represents the intermediate waypoint.

Words at the bottom right of the red block indicate the waypoint ID (waypoint altitude).

Double click a certain row in the waypoint list box, the coordinate position of this waypoint will become the center of this electronic map zone automatically.

This function can be used to search a waypoint. After selecting a waypoint in the map zone, the position can be dragged

Fig. 6.8.20. Waypoint editing operation



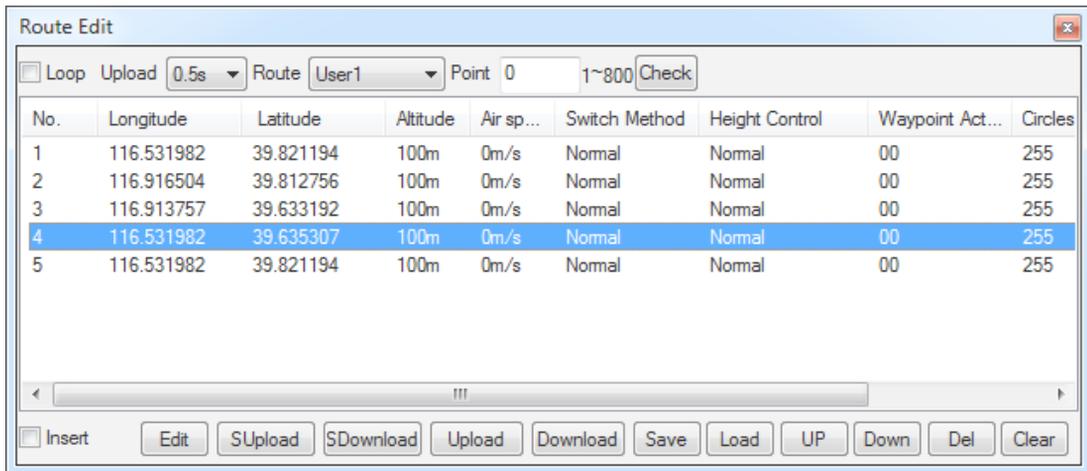


Fig. 6.8.21. Pop-up interface of waypoint editing

The waypoint editing interface is shown in Fig 6.8.21.

The upside part are the “Waypoint circulation” checkbox and selection boxes of “Waypoint upload rate” and “Route number”, the middle part is the waypoint list box and the underside part are a series of function buttons.

After the selecting the check box of “Route circulation”, the aircraft reaches the last waypoint, and it automatically switch over to the first waypoint to circulate this route.

If the check box of “Route circulation” is not selected, it will automatically switch to the circle route after reaching the last waypoint.

The “Route number” can be selected among the user route 1~ user route 8 and homing route.

The selection of the “Waypoint upload rate” is to adapt to communication links of different specifications, the value of which represents the uploading time interval among waypoints.

For links with bad signal quality, a larger time interval is selected for the “Waypoint upload rate”.

“Check” is to prevent errors during route transmission.

Generally, “Clear” all waypoints in the list box after “Route upload” to carry out “Route download”, and then carry out check; GCS will automatically compare waypoints to be uploaded and downloaded one by one.

In the middle of the waypoint editing is the waypoint list box.

The newly added waypoints is shown in the waypoint list box simultaneously, with each row representing one waypoint;

A series of function buttons at the downside of the waypoint editing interface are presented as follows:

**“Insert”**: After selecting the check box of “Route circulation”, the newly added waypoint will be automatically added to the front of the selected waypoint within the waypoint list.

**“Edit”**: Selected waypoints can be edited.

If there are multiple waypoints in the route, batch editing can be operated on a certain column of information of this route (click the title of the column), and the column of the information of all waypoints is changed simultaneously.

**“S Upload”**: Upload a selected single waypoint to S40/S50;

**“S Download”**: Download a single waypoint with specified ID in S40/S50 to GCS40;

**“Upload”**: Upload a route with specified number formulated by GCS40 to S40. GCS40 command state flashes green light when the waypoint uploading is normal, which flashes green once after one waypoint is uploaded.

**“Download”**: Download the route with specified number in S40/S50 to the waypoint list box of GCS40 and mark it in the electronic map zone. GCS40 will not display the route in the waypoints list box and electronic map zone until all the waypoints of the route are completed.

If a certain waypoint losses frame during the downloading process, then the downloading fails and GCS40 will not display the route.

**“Save”**: Save the formulated route in the hard drive of the local machine.

**“Load”**: Read the route file ever saved from the hard drive of the local machine.

**“Up”**: Move the selected waypoints up for one digit.

**“Down”**: Move the selected waypoints down for one digit.

**“Del”**: Delete the selected waypoints in the waypoint list, and the corresponding waypoint marks in the electronic map zone are also eliminated.

**“Clear”**: Delete all waypoints in the waypoint list, and all waypoint marks in the electronic map zone are also eliminated.

 **Tips:** select the shortcut tool “Waypoint editing”, double click of the left button of the mouse in the electronic map zone to add it to the route. Hold the “Shift” key and double click the left button of the mouse in the electronic map zone, then the newly added waypoint will automatically be orthogonal with the previous waypoint. Move the mouse to the waypoint added, and hold the left mouse button to drag the waypoint.

 **Notes:** the airspeed can be set upon demands during waypoint editing, and the user shall make sure the airspeed is within reasonable range, otherwise it brings safety issue! If there are no special requirements to flight speed, then the airspeed is at 0 by default, the flight control will automatically execute the cruising airspeed of the factory default set.

 **Notes:** after editing a new route and completing the “Upload”, it is generally necessary to operate the “Download” to confirm that the new waypoint editing and “Upload” are correct!

 **Notes:** GCS40 supports route files generated by other client software, which have to be consistent to the route file saved in GCS40.

 **Tips:** batch operation of waypoints: select the express tool of “Waypoint editing”, hold the “Ctrl” button in the electronic map zone, and multiple waypoints can be selected with a mouse click. Hold the left mouse button on one of the selected waypoints to “pan” the selected waypoints as a whole and pressing the “Delete” button can delete all the selected waypoints. Press the “Alt” key and the zone can be selected by the left button, and then pressing “Ctrl” + “A” to select all the waypoints in the selected zone.

 **Tips:** when operating the waypoint in the electronic map area, press “Ctrl” + “Z” to cancel the previous waypoint operation, and you can cancel up to 10 steps. The corresponding “Restore waypoint operation” button is available in the route menu bar.

## Waypoint switch

If a number of routes are set inside S40/S50, the aircraft can switch to a certain waypoint in a route during flight process by operating “Switch Waypoint”.

The aircraft can directly switch to the next waypoint in the route by “Switch Waypoint” operation in case of need to skip a waypoint in the route.

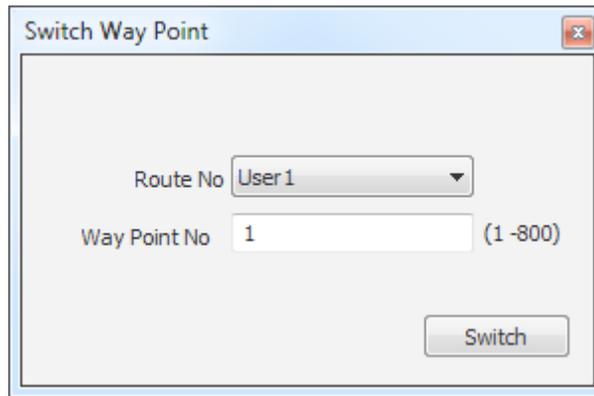


Fig. 6.8.22. Pop-up interface of switching waypoint

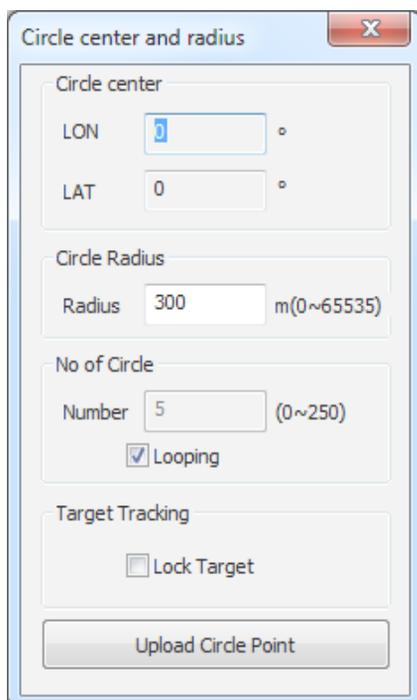
## Waypoint circle

Double click the right mouse button in the electronic map zone and the interface of circling setting pops up automatically.

The circling center is the double-click position of the mouse, and the circling radius and number of cycling turns can be set.

The circling takes into effect after sending the “Upload circle point” command

Fig. 6.8.23. Circling point setting



**Tips:** routes newly uploaded to S40/S50 cannot take into effect immediately. “Waypoint switching” operation is required to switch the aircraft to the new route, and only then the new route can navigate.



**Notes:** under the protection mode, waypoint switching through the ground station software GCS40 is not operational.

## Mapping waypoint editing

For applications of the mapping field, GCS40 provides the function of automatic waypoint editing in irregular multi-testing zone. Steps of automatic waypoint editing are as follows:

1. Select the installation method and camera model to be carried, or customize camera parameters, among which the heading course parameter is parallel to the longitudinal direction fuselage and the paraxial parameter is perpendicular to the longitudinal direction fuselage. This parameter will be automatically saved in the local machine after the setting is completed.
2. Set up the mapping scale (ground resolution ratio), course overlapping ratio and paraxial overlapping ratio according to flight mapping demand. The ground resolution ratio can adjust automatically according to the mapping scale or be inputted manually. The parameter is saved in the local machine automatically after the setting is completed.
3. Route parameters including relative flight height, route spacing and exposure interval can be calculated according to the camera parameters and aerial survey parameters above. Other route parameters (ground elevation, turning radius, flight speed) need to be inputted manually according to the actual situation. Relative flight height, route spacing and exposure interval can also be inputted manually.
4. Set the paraxial front and rear expansion (n route segments) and the course expansion (m) of the testing zone, to ensure full coverage of the testing zone;
5. Option of testing zone: Select the testing zone by an irregular polygon frame formed by N points, and the first point is the entry point and the second is the direction point. The aircraft will fly along the straight line formed by the first point and the second point;
6. Generation of temporary route: to generate a temporary route in the above testing zone, the user can drag each waypoint of the temporary route along the direction of the extension line to make the temporary route more consistent with the actual testing zone where the aircraft takes off.
7. Generation of mapping route: the aircraft automatically add turning control waypoints (in convenience of the aircraft to approach the route as quickly as possible after turning and to fly smoothly and stably) according to the adjusted temporary route and turning radius, to generate the mapping route;
8. Import of flight route: the aircraft automatically generate the actual flight route according to the above mapping route and route parameters generated. The route height is the ground elevation + relative flight height and the route speed is the preset flight speed, with the waypoint attribute automatically added to the exposure interval. After the flight route is imported, all the waypoints enter into the waypoint list box in the waypoint editing interface. The user can directly upload the waypoints to the aircraft controller or reedit them as required;
9. If the multi-monitoring flight area is needed for one time, repeat step 4) ~7), then waypoints in the multi-monitoring area can be connected into one route automatically;
10. During the automatic planning process, click "Clear task" to abort the planning.

## Mapping waypoint editing

**! Notes:** during automatic waypoint editing, the user can set the airspeed on demand, and make sure the airspeed is within reasonable range; otherwise it brings safety risk!

If there is no special requirement to flight speed, the airspeed is at 0 by default, the flight control will automatically execute the cruising airspeed of factory default setting.

**! Notes:** When selecting the testing zone, the right indicator shall be green, otherwise the control point cannot be selected. If it is gray, the indicator will turn green by clicking.



**Skills:** When selecting the testing zone, express operations are as follows:

1. Click the left mouse button to select a certain control point, which can be dragged.
2. For the quadrilateral testing zone, hold down the SHIFT key, and double click the left mouse button to add new control point of the testing zone, which automatically maintains vertical(rectangle).
3. For the quadrilateral testing zone, hold down the SHIFT key, click the left mouse button to drag a certain control point, which automatically maintains rectangle. Irregular quadrangle will automatically transform into a rectangle, and the diagonal point and the directions of 1-2 sides of the control point remain unchanged during the dragging process.
4. Pressing the CTRL key, click the left mouse button to select a certain control point to drag the entire testing zone;
5. Pressing the ALT key, click the left mouse button to select a certain control point to rotate the entire testing zone.

## Mapping waypoint editing

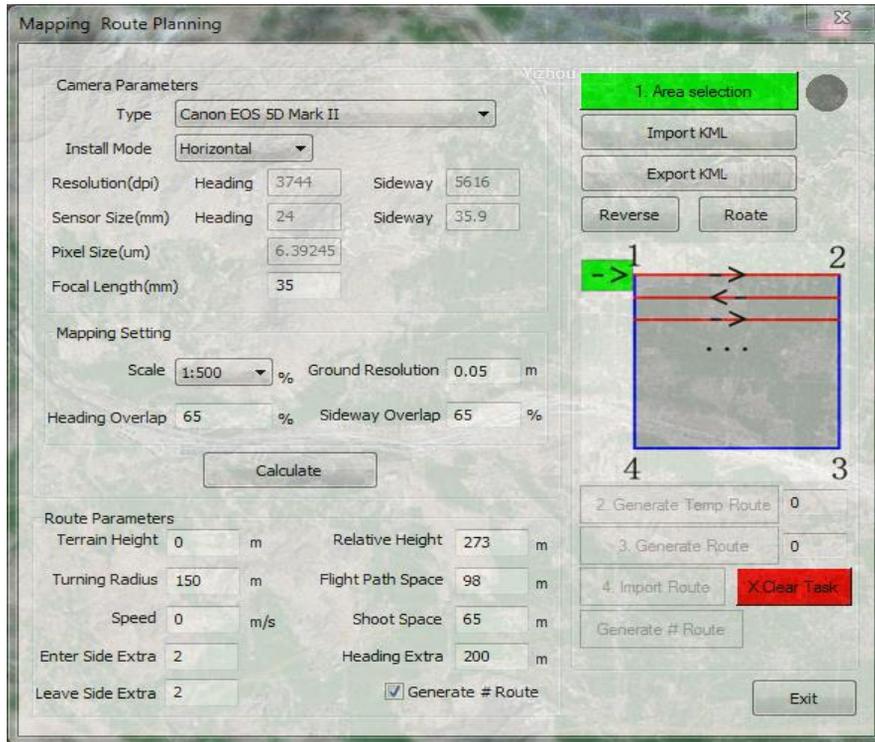


Fig. 6.8.24a. Automatic waypoint editing

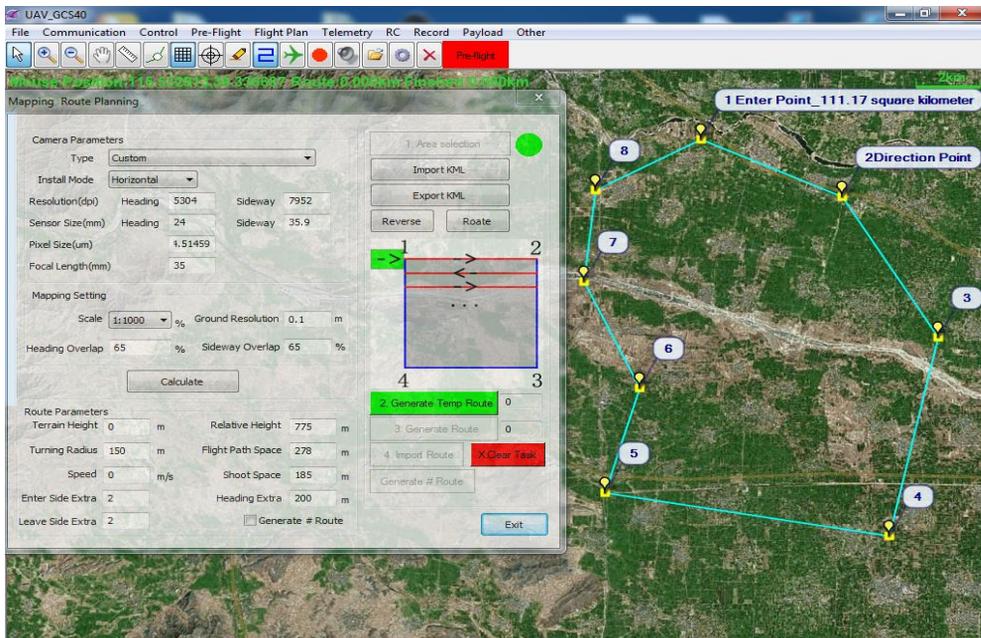


Fig. 6.8.24b. Select arbitrary polygon testing zone

## Mapping waypoint editing

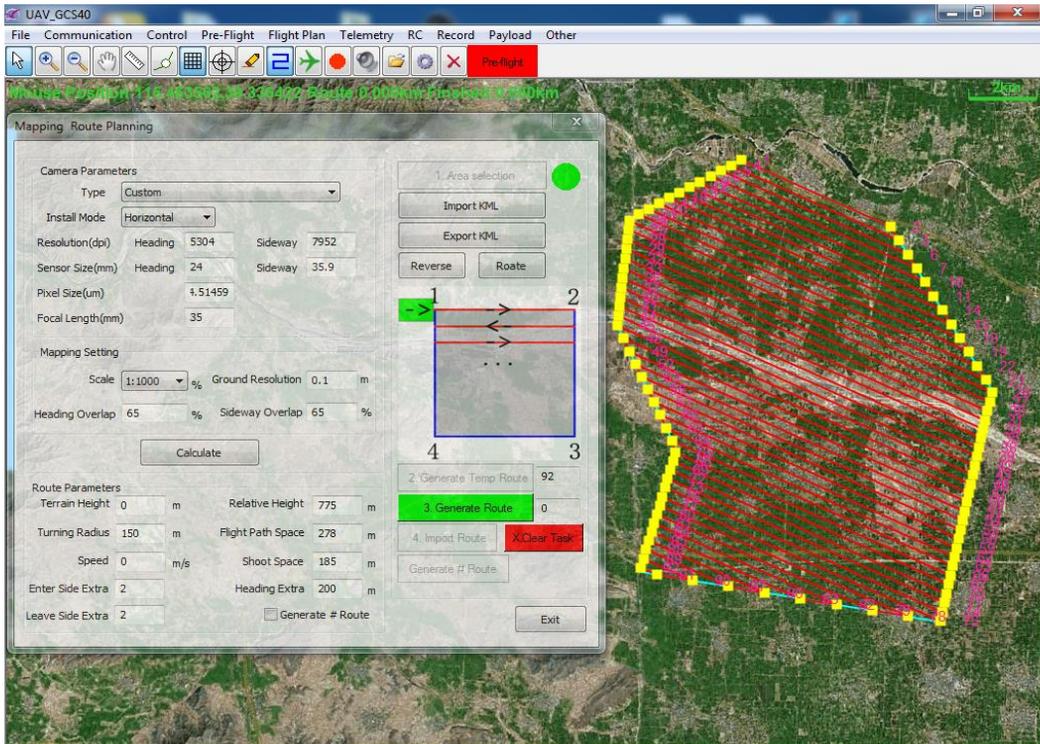


Fig.6.8.24c Generate temporary route

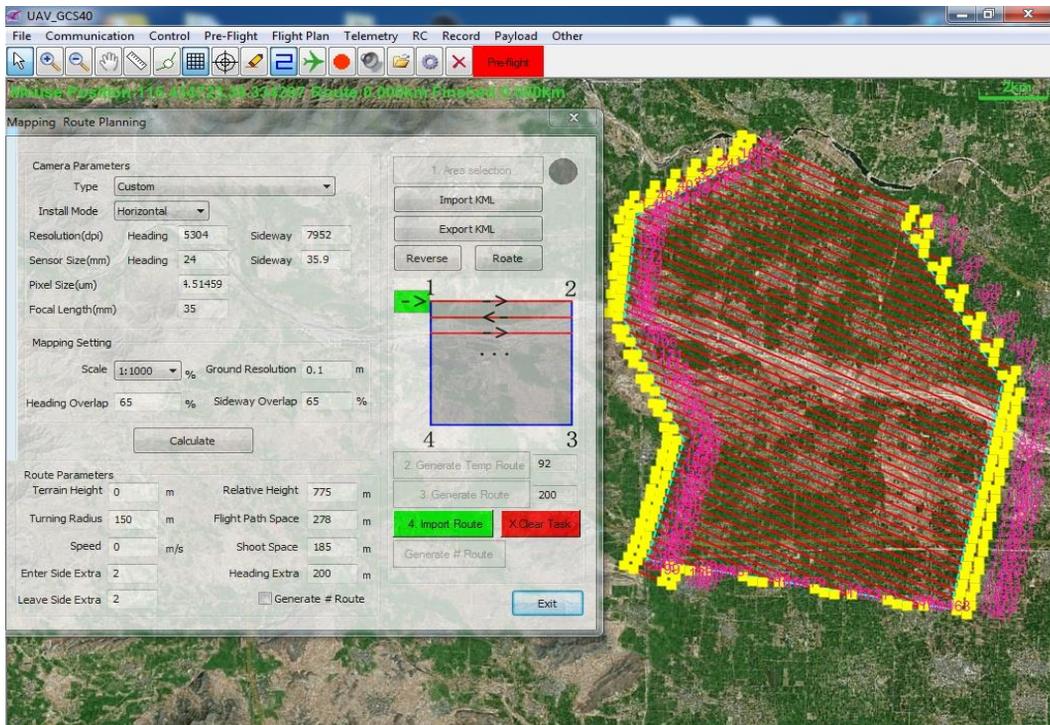


Fig. 6.8.24d Generate mapping route

## Mapping waypoint editing

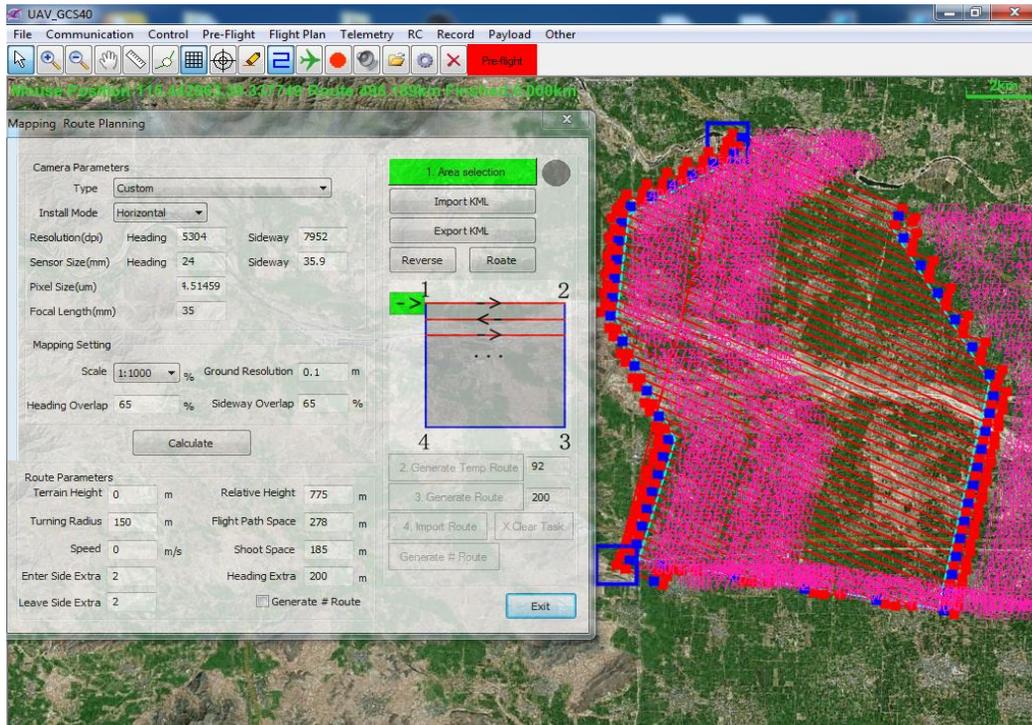


Fig.6.8.24e Import flight route



**Skills:** prior to “Generate temporary route”, hold down the CTRL key, drag the left mouse button to draw the route reference direction, click the right button to cancel. If a route reference direction is drawn, the automatic planning will give priority to editing waypoint in accordance with this direction

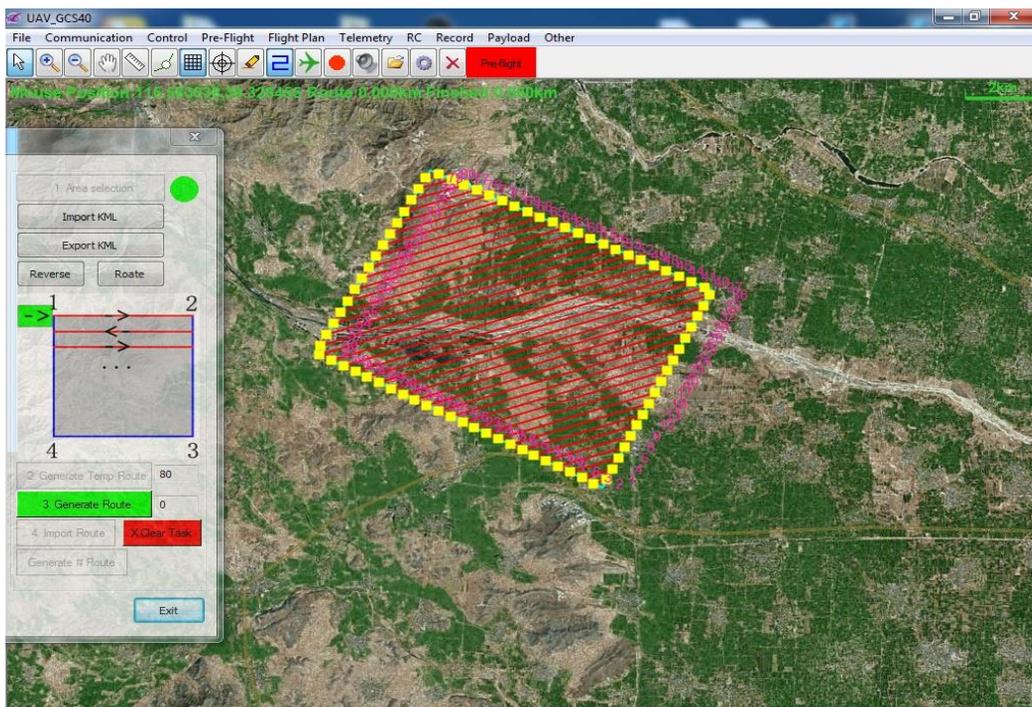


Fig. 6.8.24f CTRL+left mouse button to draw the route reference direction

### Mapping waypoint editing

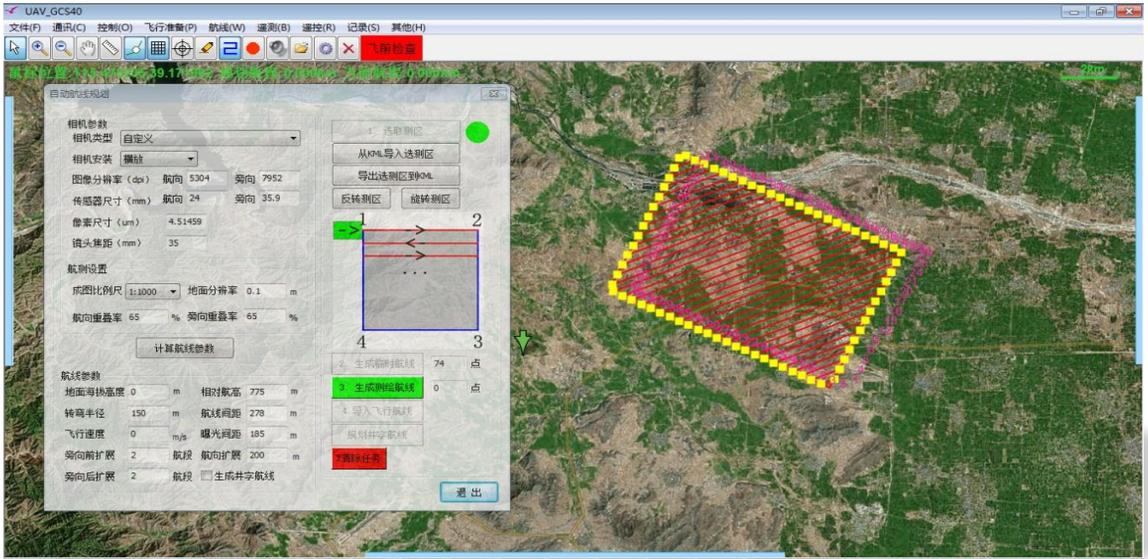


Fig. 6.824g CTRL+left mouse button to draw the route reference direction



**Skills:** to generate “#” route, the user shall select “Generate Tic-Tac-Toe Line” box.

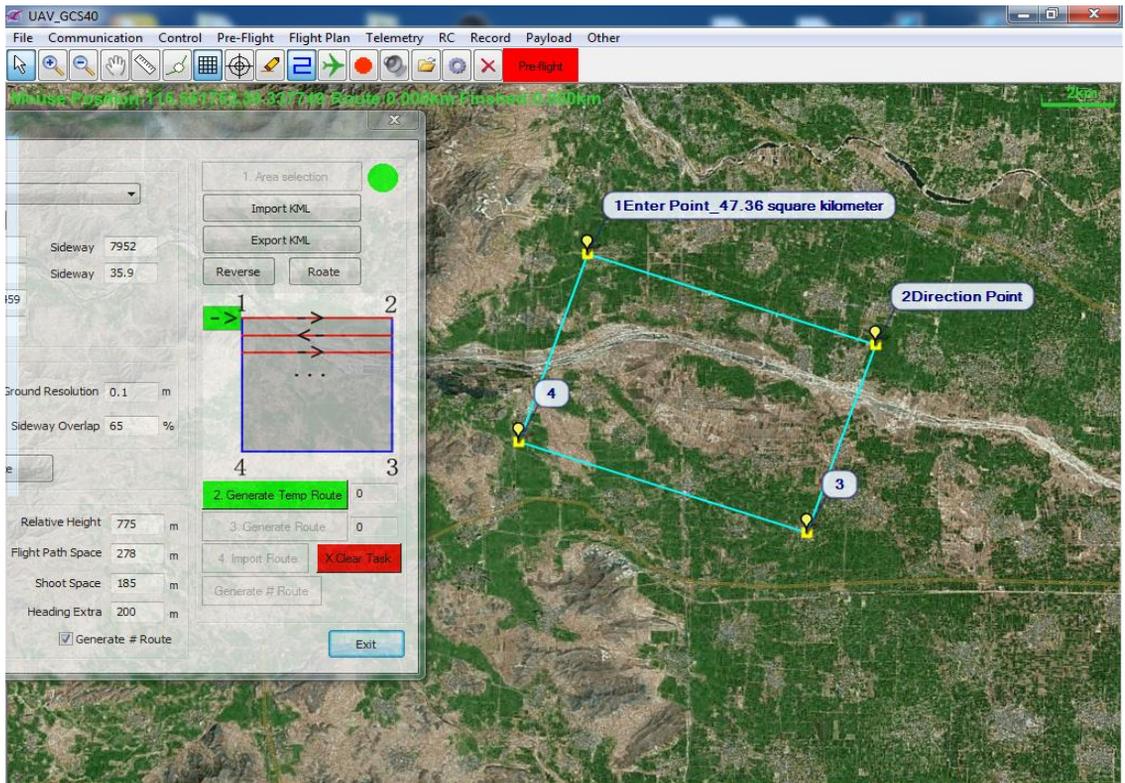


Fig. 6.824h Select “Generate Tic-Tac-Toe Route”

## Mapping waypoint editing

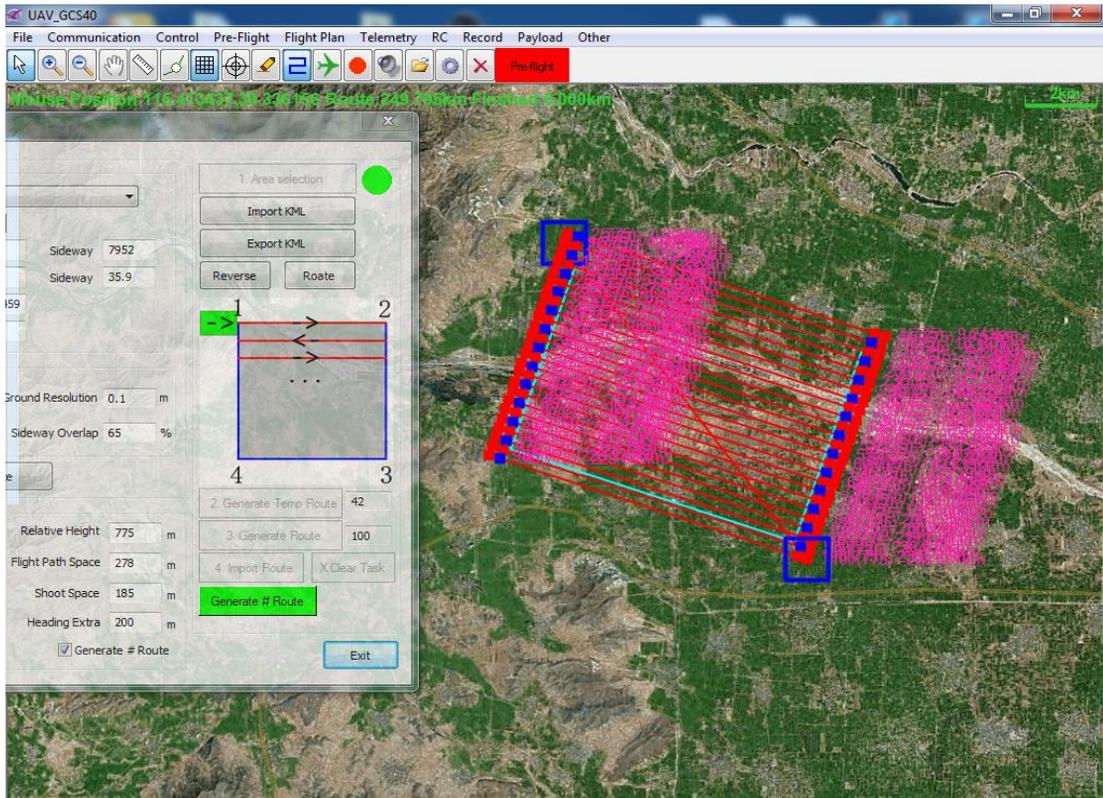


Fig. 6.8.24i Complete the first importing flight route, reselect editing Tic-Tac-Toe route

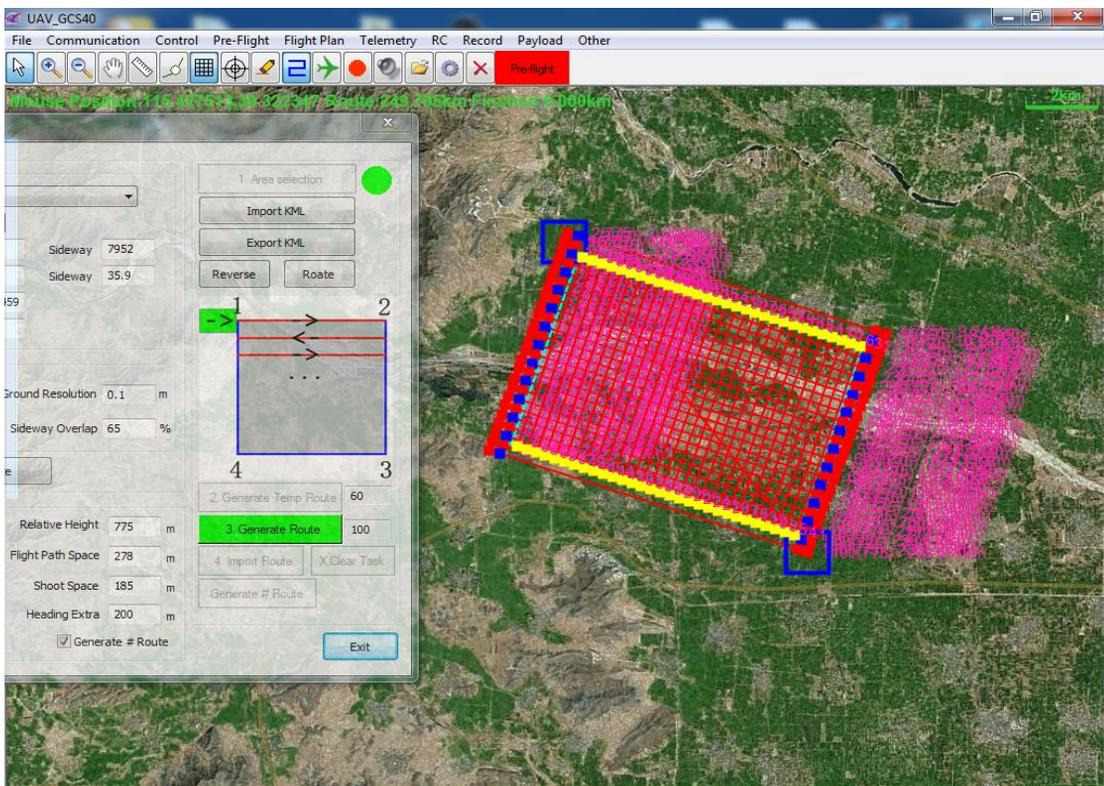


Fig. 6.8.24j Regenerate vertical mapping route

### Mapping waypoint editing

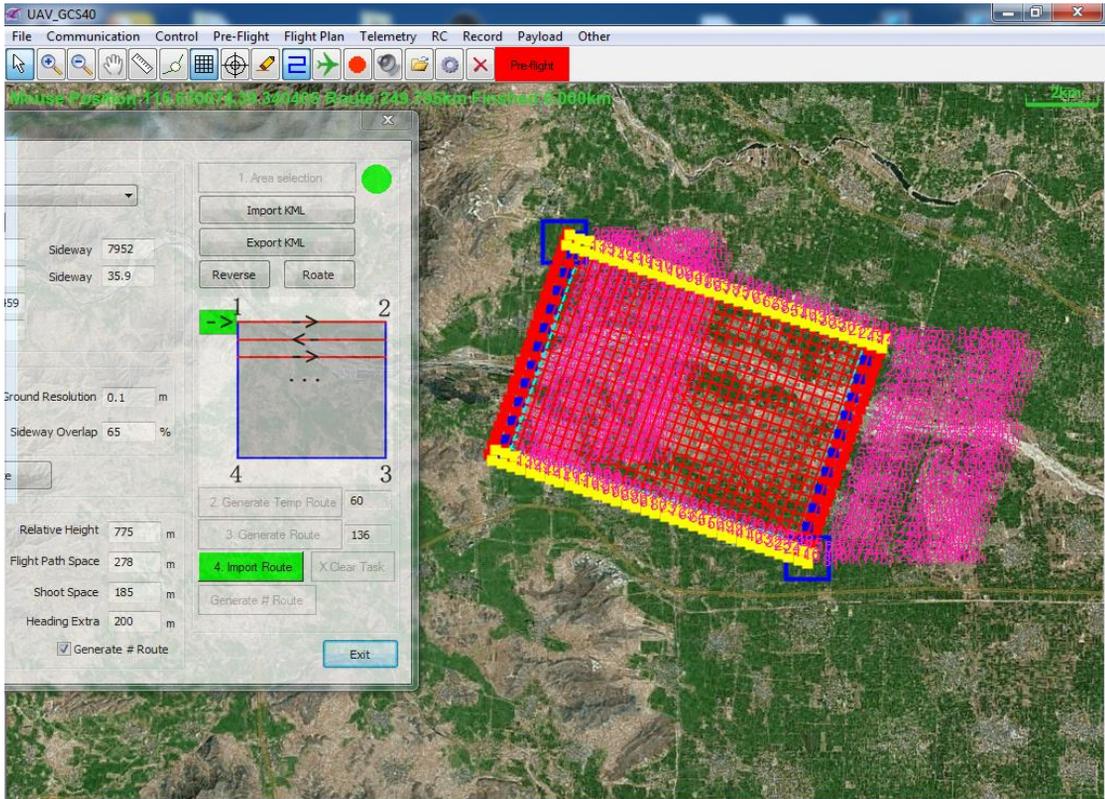


Fig. 6.8.24k Regenerate vertical mapping route

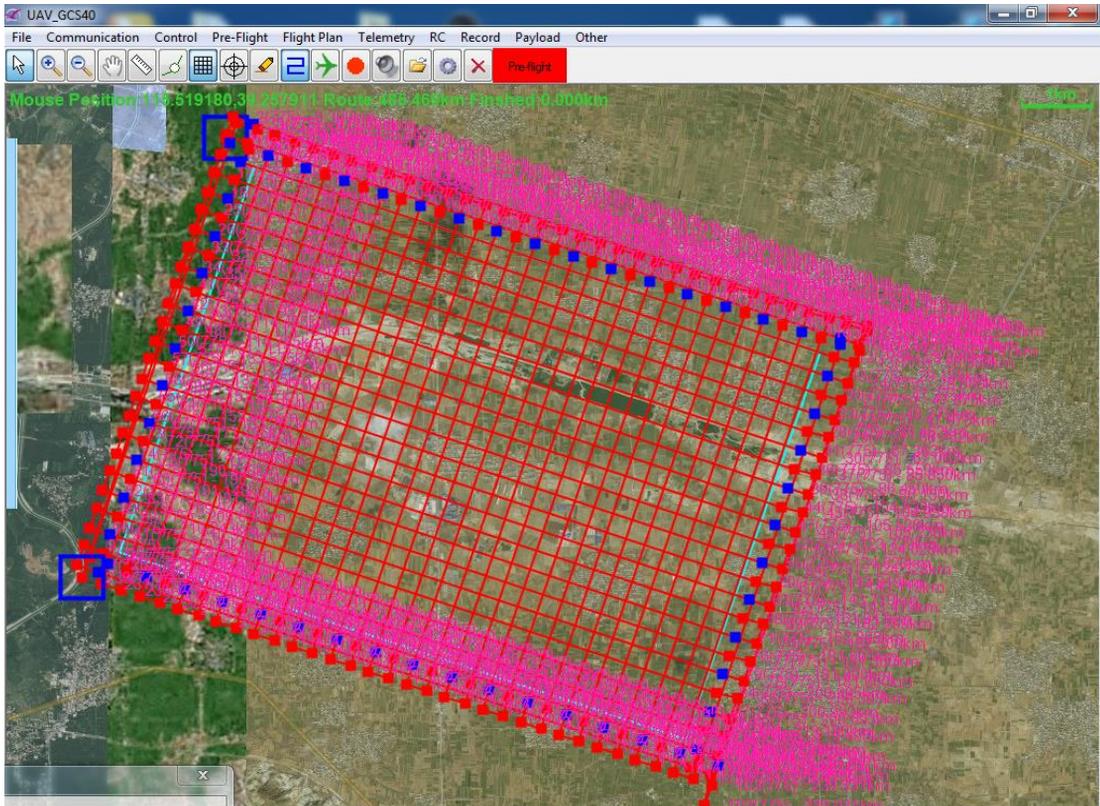


Fig.6.8.24l Reimport vertical mapping route, to complete the generation of the Tic-Tac-Toe route

## Mapping waypoint editing



**Tips:** After the formulation of mapping route, the generation of simulated photographing data is operational, to verify the rationality of the camera points and the number of photos taken, route menu → generate simulated camera data. The center of each circle in the picture is the photographing position, and the number next to the circle is the number of the photographing point.



**Tips:** After exporting the POS data, the map interface can be imported again for checking, recording menu → import POS data.

Fig. 6.8.24m Generate simulated POS data and import POS data

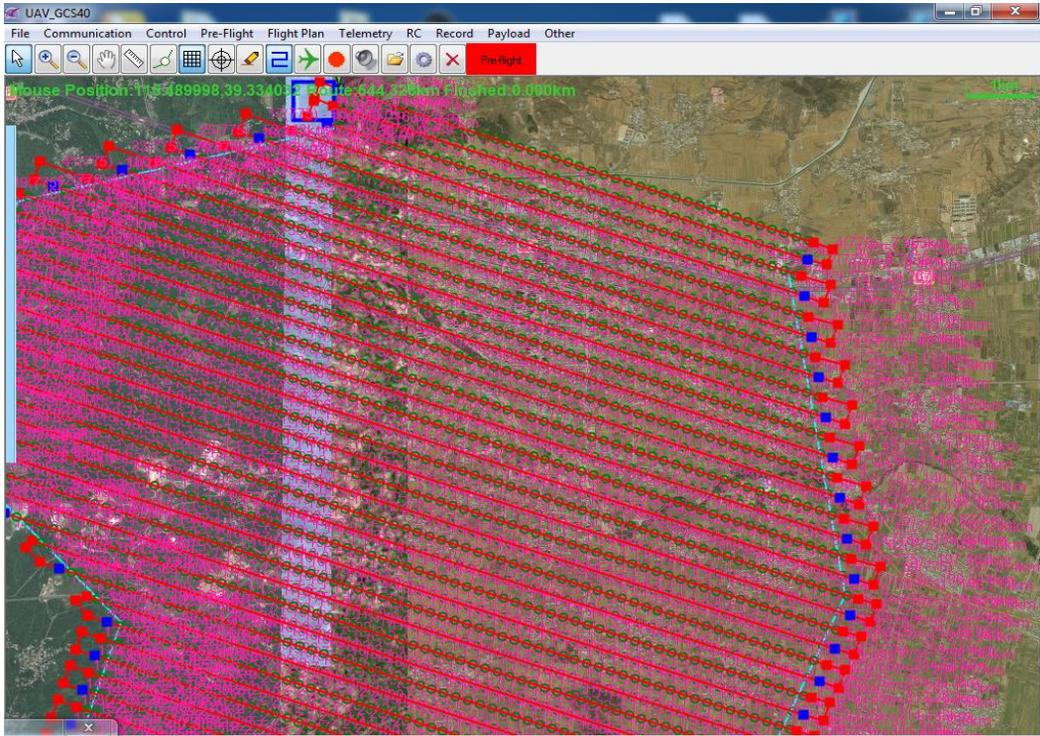
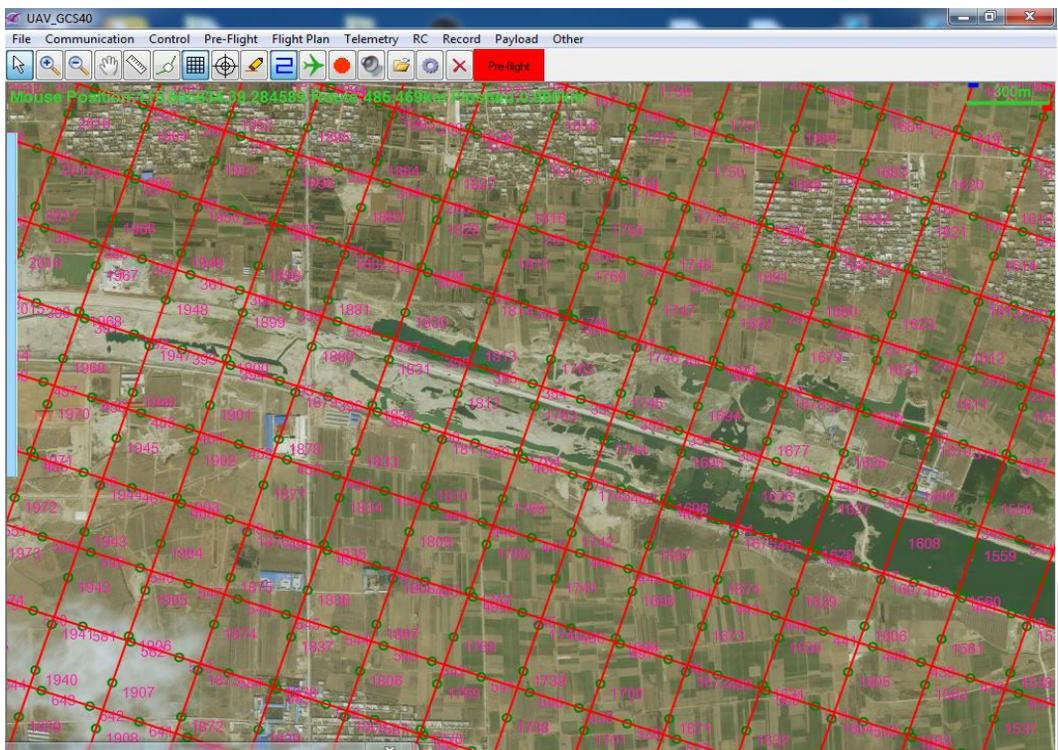


Fig. 6.8.24n POS data



## Mapping waypoint editing

### Patrol line and waypoint editing

For the application of electric/oil and other pipeline inspection field, GCS40 provides the patrol line and waypoint editing function. The automatic planning steps are as follows:

1. Choose the model and installation mode of the camera to be carried, or customize camera parameters, among which the heading course parameters are parameters in the direction parallel to the longitudinal fuselage and the paraxial parameters are parameters in the direction perpendicular to the longitudinal fuselage. This parameter is saved in the local machine automatically after the setting is completed.
2. Set up the mapping scale (ground resolution ratio), course overlapping ratio and lateral overlapping ratio according to patrol line demand; the ground resolution ratio can be adjusted automatically according to the mapping scale or be inputted manually. This parameter will be saved in the local machine automatically after the setting is completed.
3. Route parameters can be calculated according to the above camera parameters and aerial survey parameters, which include relative flight height, route spacing and exposure interval (the patrol line adopts timed photographing which finally is executed based on exposure interval). Other route parameters (turning radius, flight speed) need to be inputted manually according to the actual situation. relative flight height, route spacing, exposure spacing and exposure interval can also be inputted manually.
4. Read the files: read in pipeline coordinates file, and support TXT and KML format. Each coordinate point needs longitude (unit: degree), latitude (unit: degree), and altitude (unit: m), among which, the example of the TXT format are as follows: the first line is header, the first column is serial number, both of which cannot be ignored. The “reverse” button can select the coordinate point to start to enter (the user can select the first or the last point as the entry point).
5. Generate temporary route: generate temporary route at both sides of the above pipelines. The “reverse” button can select to enter from the left side or right side of the pipelines;
6. Generate patrol line and route: add turning control waypoints (so that the aircraft can fly smoothly and stably in the effective route segment) automatically according to the adjusted temporary route and the preset turning radius, to generate the patrol line and route. When the turning angle of route is larger than the preset angle, it automatically add turning control waypoints. If the turning control waypoints passed through the pipeline, to avoid the risk caused by the aircraft flying over the pipeline, select “Do not pass pipeline” and the system will automatically cancel the turning control waypoints that will pass through the pipeline.

## Mapping waypoint editing

1. Import flight route: generate the actual flight route automatically according to the above patrol line and route and the preset route parameters. The route height is the pipeline coordinates elevation + relative flight height; the route speed is the flight speed that has been set (0 refers to the default of the cruising speed); employ timed photographing, and if the flight speed is set, the exposure interval will be calculated automatically according to the exposure spacing. After the flight route is introduced, all waypoints enter into the waypoint list box in the waypoint editing interface. The user can upload the waypoints to the aircraft controller directly and reedit them on demand.
2. If the multiple pipelines are needed for one time, repeat step 4) ~7), then waypoints in the multiple pipelines automatically connect into one route.
3. Click “Clear task” in the automatic planning process to abort the planning

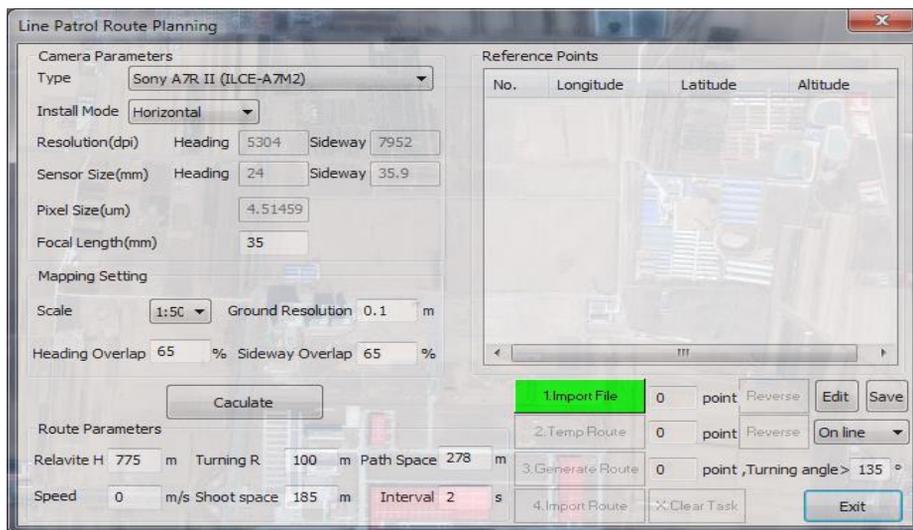


Fig 6.8.24o Read pop-up interface of patrol line planning

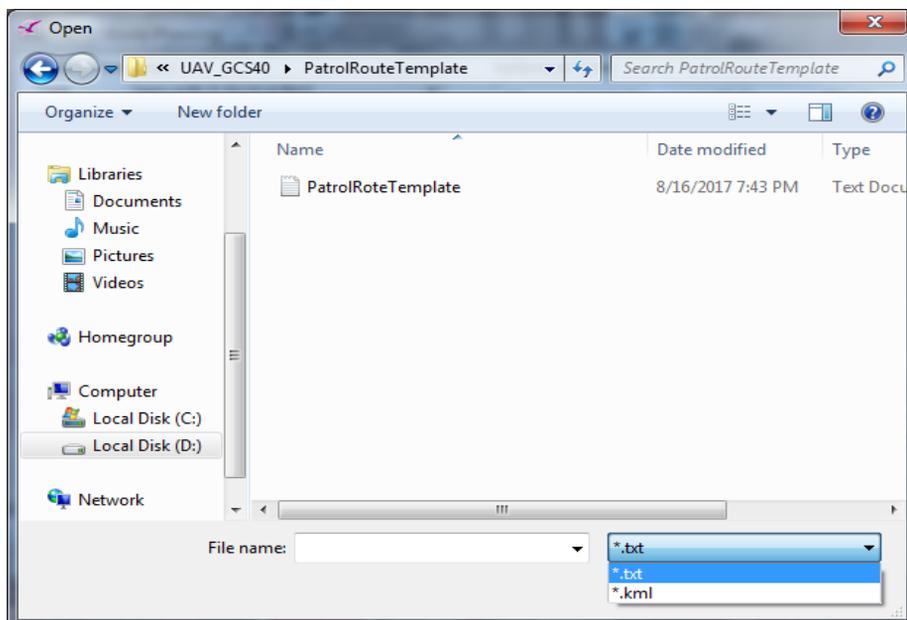


Fig 6.8.24p Read patrol line coordinate files

### Mapping waypoint editing

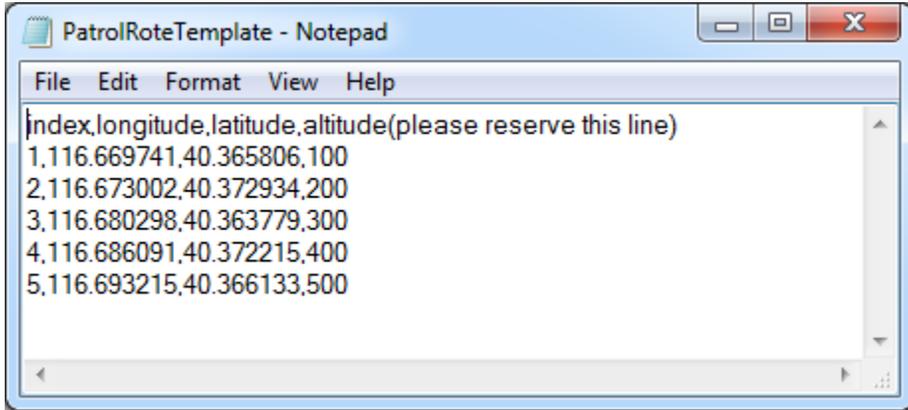


Fig. 6.8.24q Example of the format of TXT patrol line coordinate file

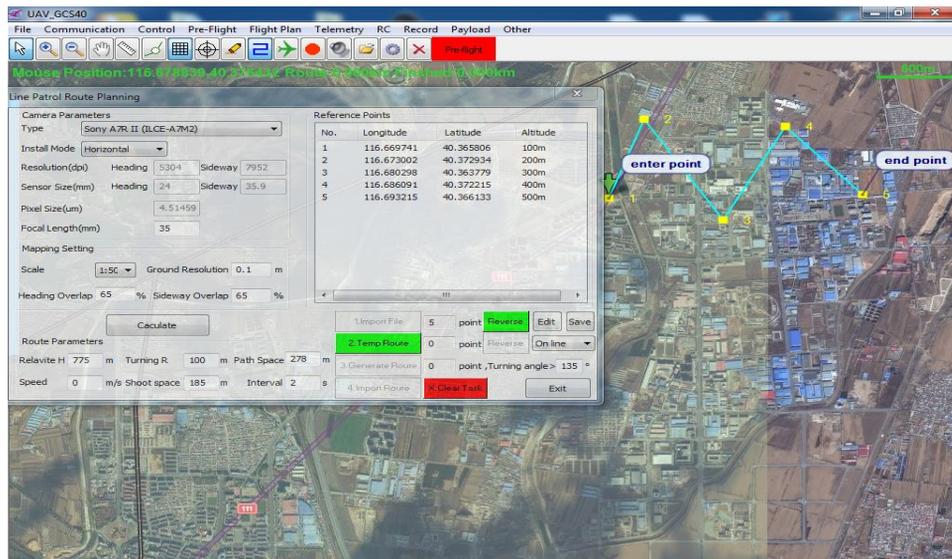


Fig. 6.8.24r Read in pipeline coordinate files

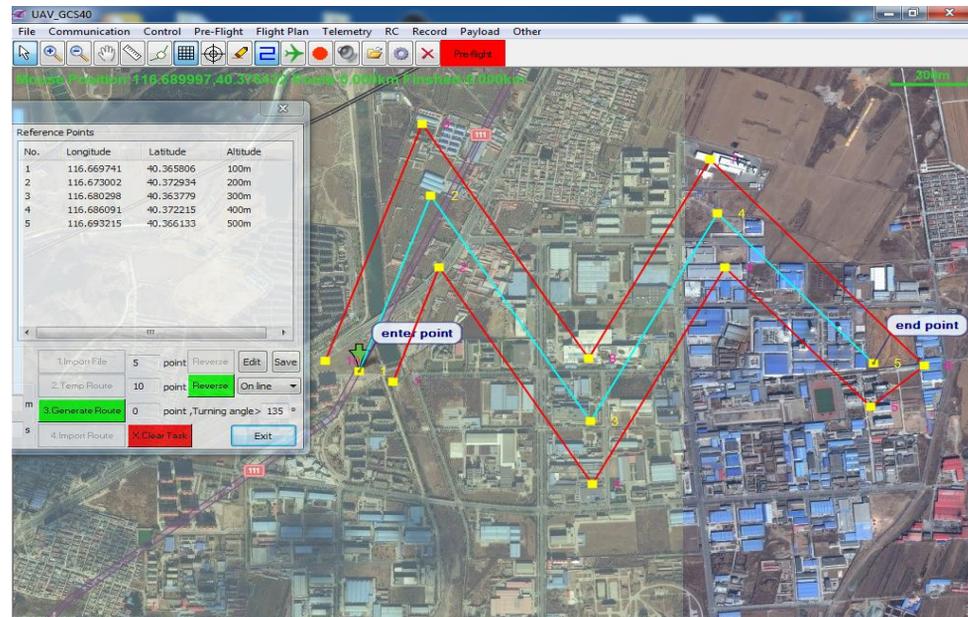


Fig. 6.8.24s Generate temporary route

# Mapping waypoint editing

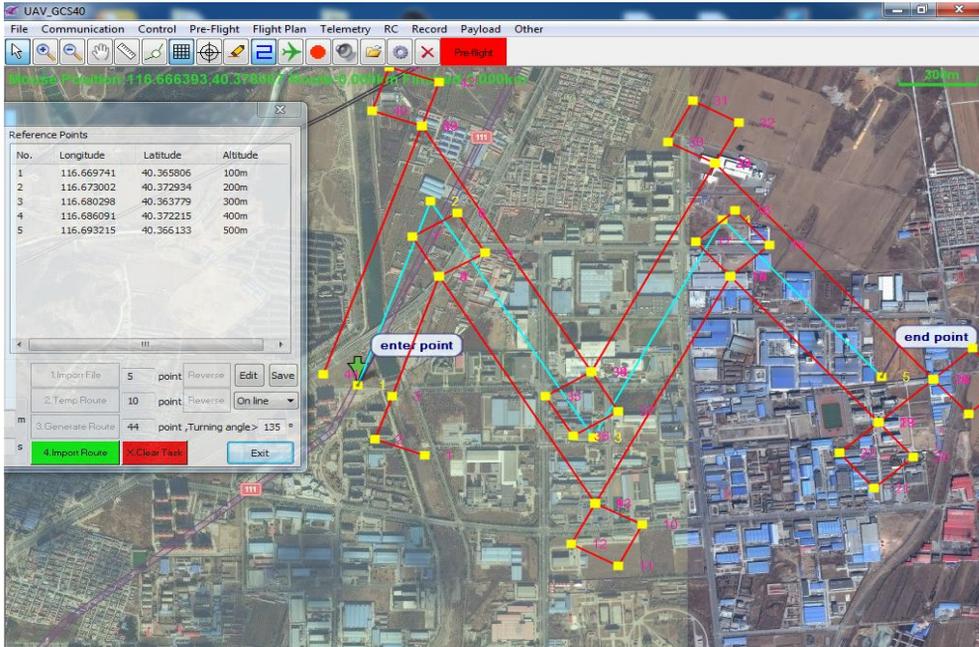


Fig. 6.8.24t Generate patrol line and route (passing line permitted)

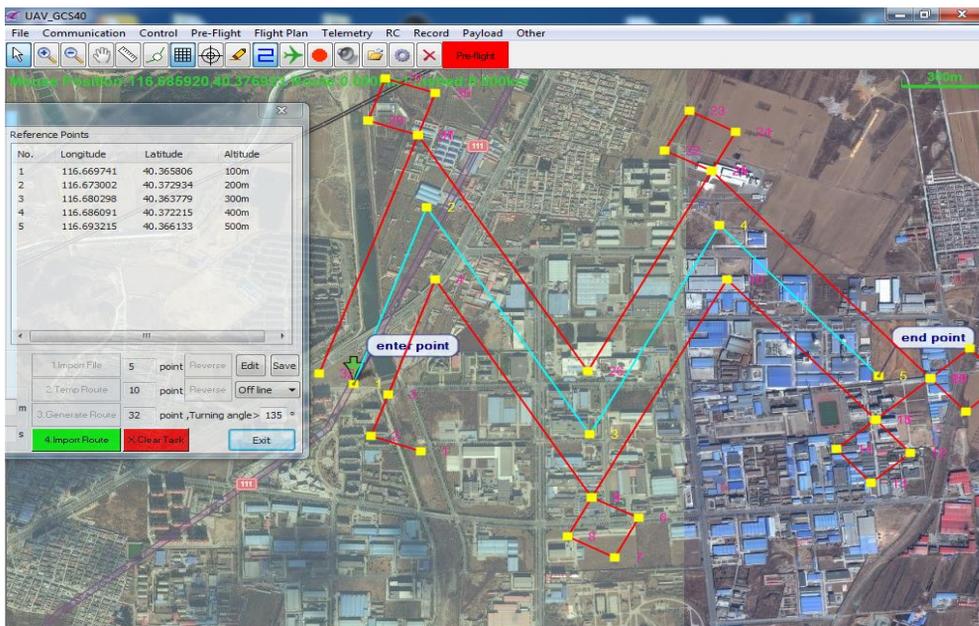


Fig. 6.8.24u Generate patrol line and route (passing line forbidden)

Fig. 6.8.24s Generate temporary route

## Mapping waypoint editing

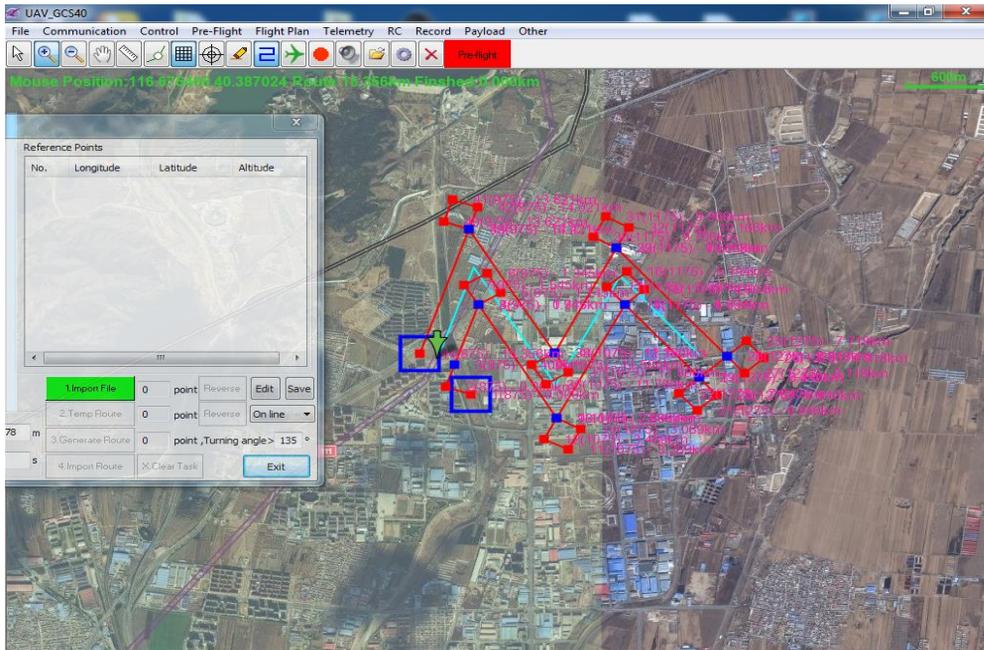


Fig. 6.8.24v Import flight route (passing line permitted)



**Tips:** If the pipeline coordinate file provided by the user does not contain altitude information (which can not be exported with unauthorized google earth), then the altitude information of each coordinate point can be checked through the elevation calibration tool provided by

UAV\_GCS40. The operations are as follows:

1. Enter "Route" menu, open route altitude calibration tool.
2. Click the height query on the "altitude calibration" tool interface.
3. Open the original coordinate file (kml) provided by the user without elevation information.
4. Save the query result as a coordinate file (txt) with elevation information.
5. Enter patrol line and route planning interface, read the file selection step 4) stored coordinates file with elevation information (txt), to check the altitude information of each coordinate point.
6. According to the procedure to carry out the next-step planning, the user route finally generated can be imported directly into the route height calibration tool for height inspection, or be stored as kml format and then imported into google earth for verification.



**Notes:** the route altitude calibration tool provided by UAV\_GCS40 is based on the offline elevation database, so the above operation can be finished without networking.

Fig. 6.8.24s Generate temporary route

## Mapping waypoint editing

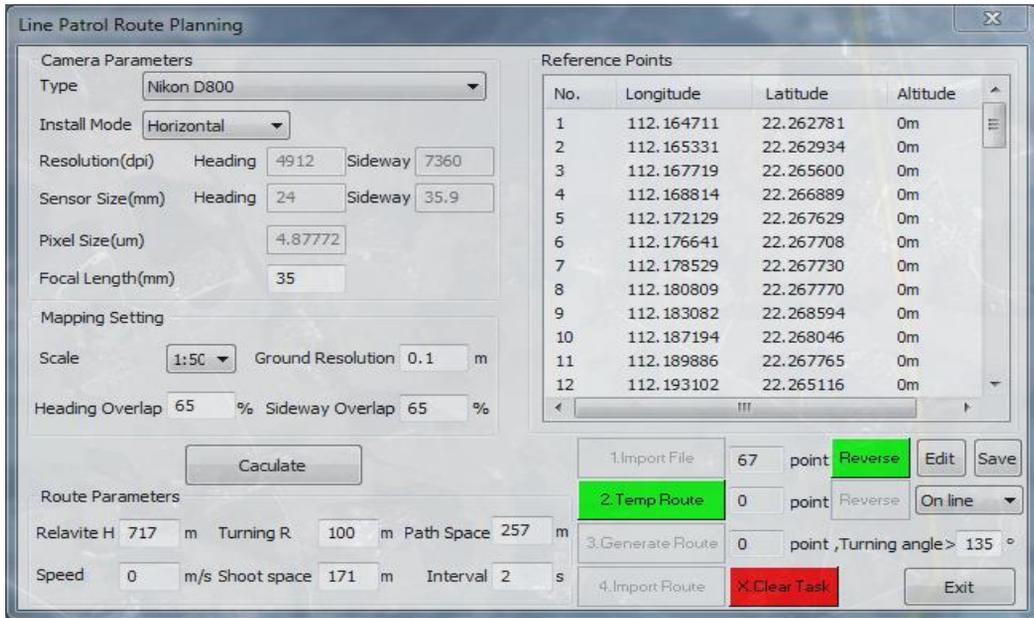


Fig. 6.8.24v1 KML coordinate file provided by the user without elevation information (altitude and height at 0)

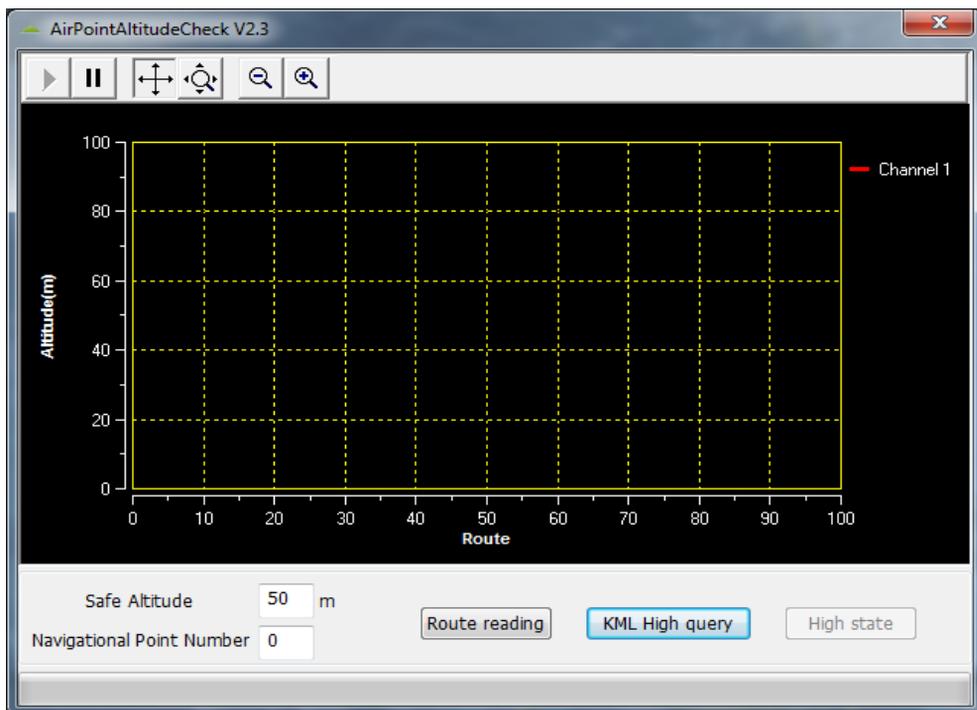


Fig. 6.8.24v2 Check the KML altitude through waypoint altitude calibration tool

## Mapping waypoint editing

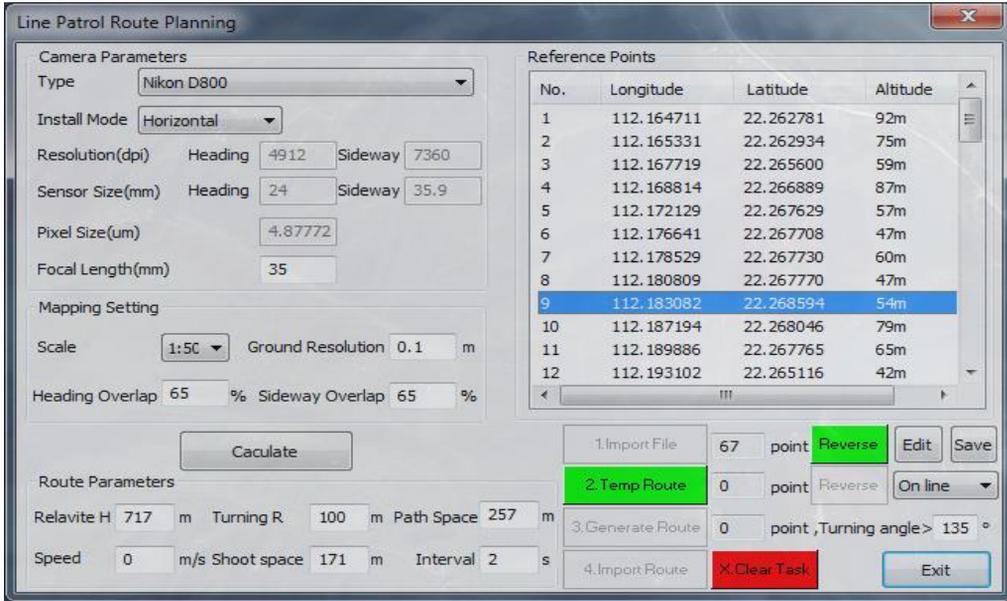


Fig. 6.8.24v3 Reimport the file after height query into patrol line and route (with elevation information)



**Tips:** After completing waypoint editing, the user can check the voyage from each waypoint to the first point in the waypoint editing box, and the map interface also displays each waypoint and voyage

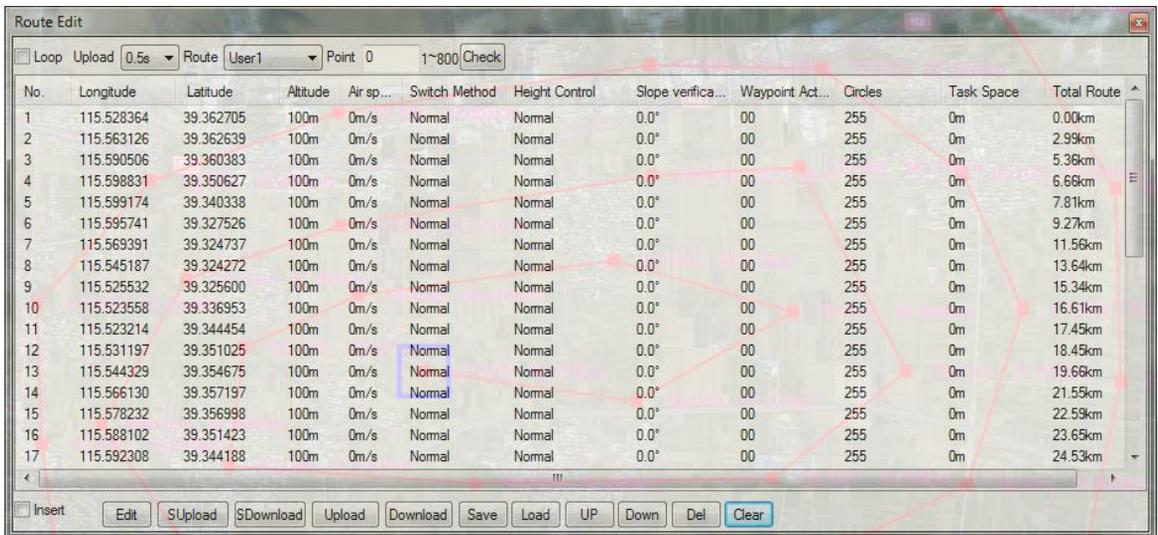


Fig. 6.8.24w Reimport the file after height query into patrol line and route (with elevation information)



**Tips:** In the route planning frame, press CTRL to select multiple discontinuous points to delete and press SHIFT to select multiple continuous points to delete.

## Mapping waypoint editing

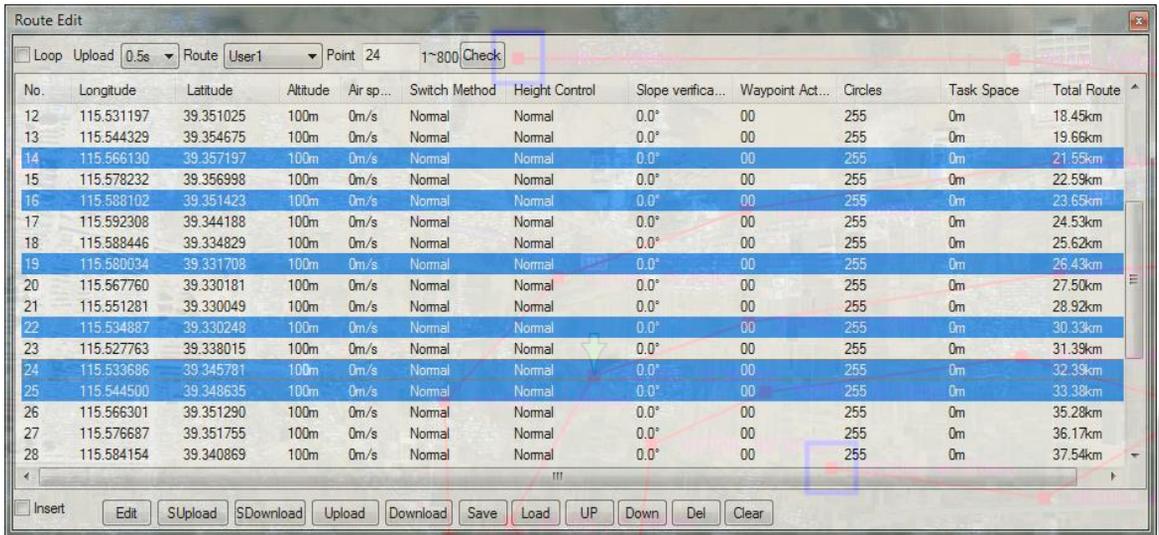


Fig. 6.8.24x Press the CTRL key, to select multiple discontinuous point to delete

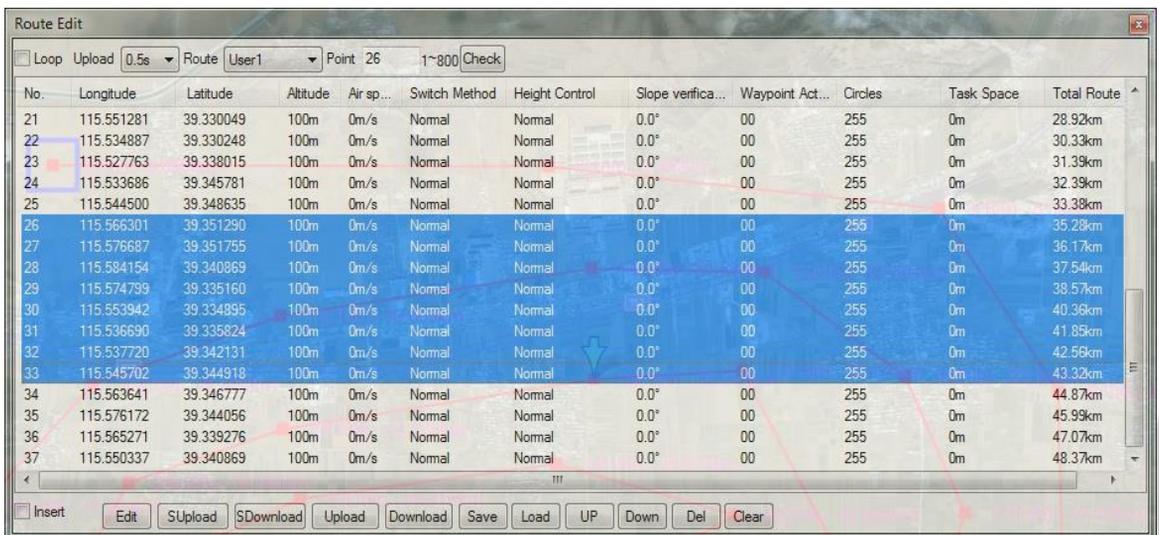


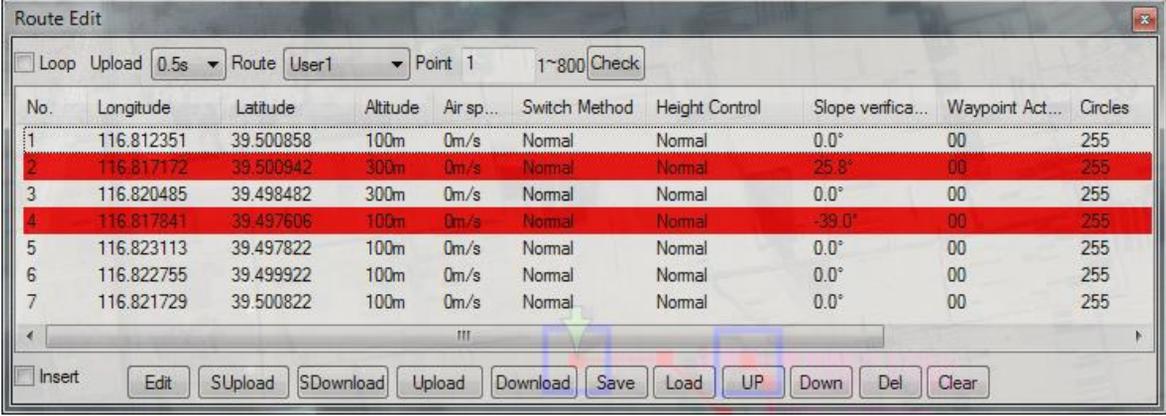
Fig. 6.8.24y Press the SHIFT key, to select multiple continuous points to delete



**Tips:** After the waypoint editing is finished, the user can check the gradient of each route segment (route trim angle) in waypoint editing box.

Alarm sound automatically rings if the gradient is smaller or larger than 15 degree(the color of this waypoint information turns red)..

## Mapping waypoint editing



No.	Longitude	Latitude	Altitude	Air sp...	Switch Method	Height Control	Slope verifica...	Waypoint Act...	Circles
1	116.812351	39.500858	100m	0m/s	Normal	Normal	0.0°	00	255
2	116.817172	39.500942	300m	0m/s	Normal	Normal	25.8°	00	255
3	116.820485	39.498482	300m	0m/s	Normal	Normal	0.0°	00	255
4	116.817841	39.497606	100m	0m/s	Normal	Normal	-39.0°	00	255
5	116.823113	39.497822	100m	0m/s	Normal	Normal	0.0°	00	255
6	116.822755	39.499922	100m	0m/s	Normal	Normal	0.0°	00	255
7	116.821729	39.500822	100m	0m/s	Normal	Normal	0.0°	00	255

Fig. 6.8.24z Route slope (pitch angle) automatically checks, alarm



**Notes:** UAV\_GCS40 provides route height calibration function to prevent collision problem due to inaccurate determination of the user on the ground elevation below the route after editing the waypoint.

The altitude calibration tool provided by UAV\_GCS40 is based on the offline elevation database, and can be completed without networking. Specific steps are as follows:

1. Enter “Route” menu, open route altitude calibration tool.
2. Set the safety height threshold, at 50m by default. Alarm sound rings when the difference between route height and ground altitude is less than the safety height threshold.
3. Click the Read Route button on the “Route Altitude Calibration” tool interface.
4. Open the formulated route document (WPT), to calibrate the altitude.
5. If the height status turns red, then the route altitude alarm rings.
6. The user can open the alarm information to check the alarm status of each waypoint in detail.

## Mapping waypoint editing



Fig.6.8.24z-1 Route altitude calibration

The screenshot shows the 'Altitude alarm' window with a table containing the following data:

waypoint	flight altitude	ground altitude	safe altitude	height difference
1-2	100	106	50	-56
2-3	100	62	50	-12
3-4	100	60	50	-10
4-5	100	60	50	-10
5-6	100	70	50	-20
6-7	100	71	50	-21

Fig.6.8.24z-2 Altitude alarm information

### 6.8.6 “Telemetry”

“Telemetry” menu includes the telemetry data, frame frequency, bit error rate and other options.

#### Telemetry data

The pop-up interface of telemetry data displays the complete telemetry data for the user to check the detailed status of aircraft.

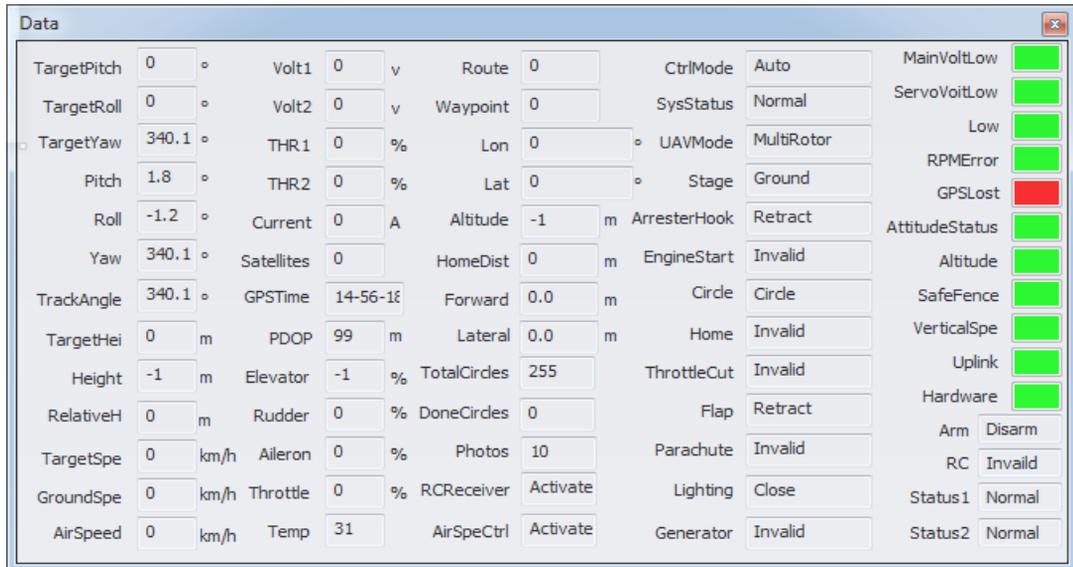


Fig. 6.8.25 Complete telemetry data

#### Config data frequency

After clicking the button “Connect” in the key commands zone of main interface and the connection is normal, S40/S50 will timely send telemetry data packages to GCS40.

The sending frame frequency of telemetry data packet is adjusted through the pop-up interface of the telemetry rate setting. The telemetry rate is 1Hz by default.

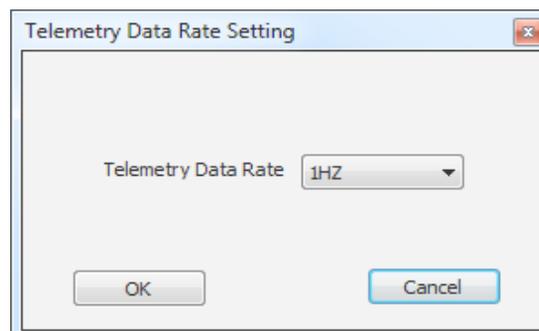


Fig. 6.8.26 Telemetry rate setting

### 6.8.7 “Remote control”

“Remote control” menu includes forward speed control, altitude increment control, switch command, number of circle rounds, enforcing mode switch and payload remote control, etc. The above remote control command (except remote control of navigation light and load) are valid only in the full-auto mode.

#### Forward speed

To change the flight speed of the current route segment temporarily

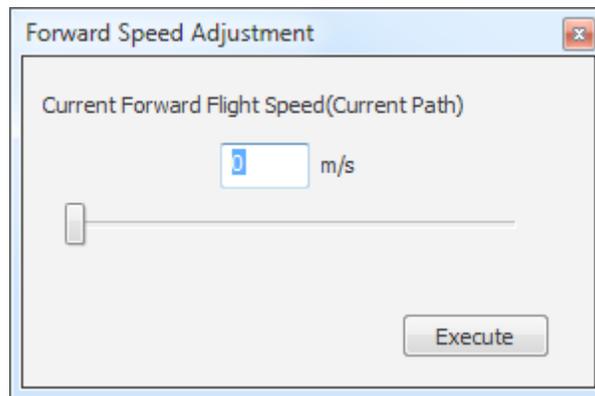


Fig. 6.8.27 Forward speed

#### Altitude increment

To change the flight altitude of the current route segment temporarily. The target altitude is the current altitude+ altitude increment

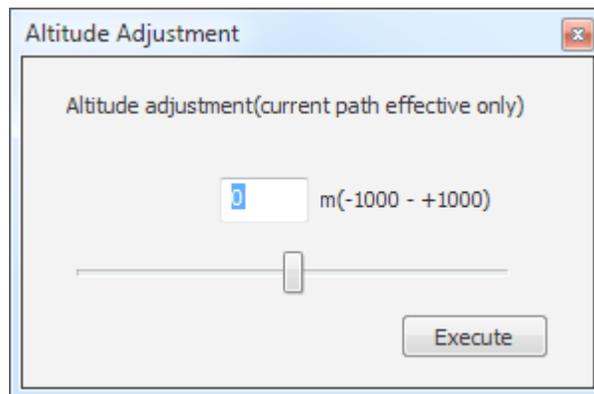


Fig. 6.8.28 Altitude increment

## Throttle fine tune

In the full-auto mode, if the airspeed control is invalid, the throttle can be directly adjusted through the fine-tuning. If the airspeed control is effective and the throttle fine-tuning does not work, the throttle is controlled by the airspeed closed-loop

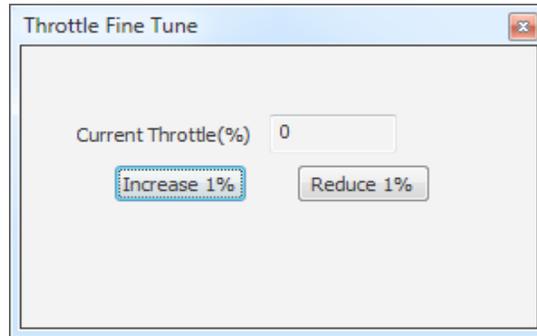


Fig. 6.8.29 Throttle fine tune

## Switch command

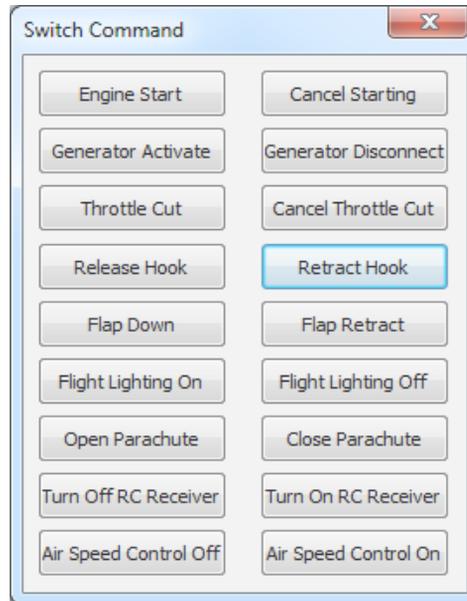


Fig. 6.8.30 Switch command

## Number of circling turns

Using the current position as the center, the aircraft circles maintaining the current altitude. The number of circling rounds can be set

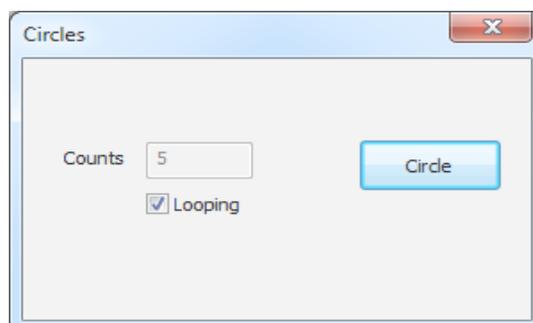


Fig. 6.8.31 Circle setting

## Enforcing mode switch

The “fixed-point hover” function in switch mode of S40/S50 has not been activated.

If it has to switch to the multi-rotor mode during fixed-wing flight, GCS40 can send the “Enforce Multi-rotor” command. After completion of the multi-rotor mission, it will send the “Resume Automatic Switch” command.

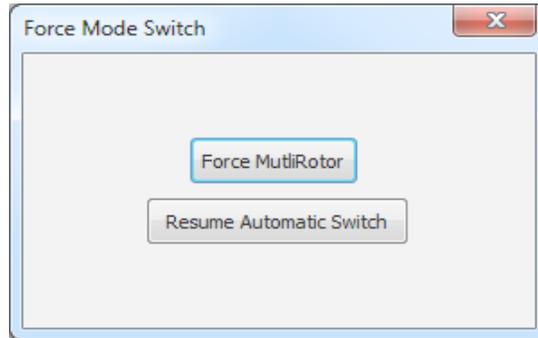


Fig. 6.8.32 Enforcing mode switch

## Payload Remote control

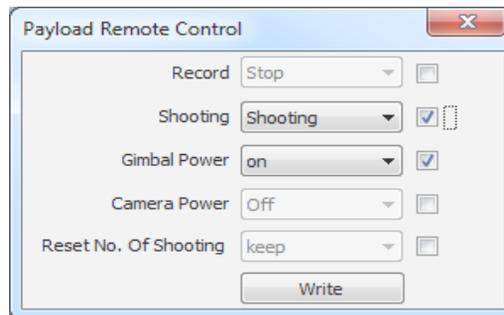
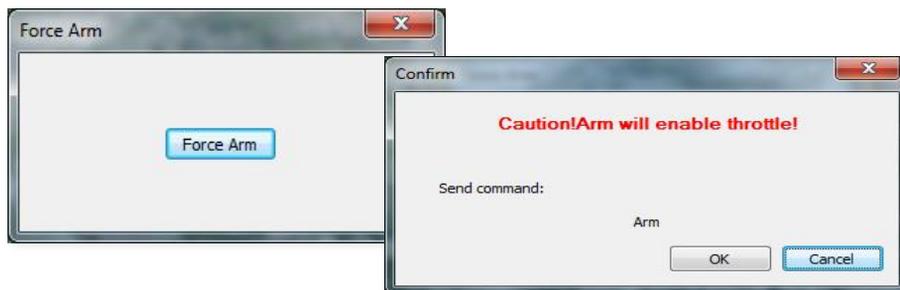


Fig. 6.8.33 Payload remote control

## Enforcing unlock

Under normal circumstances, the flight control is unlocked by the operation through the “Eight” action inside the remote controller to achieve. In case of emergency which is inconvenient to operate the “Eight” unlock action, enforcing unlocking can be achieved through the ground station software.



**Notes:** Enforcing unlock takes into effect only when the flight control is on the ground segment.

**Notes:** Mandatory unlocking is a high-risk command, the throttle directly takes into effect after unlocking, please confirm the throttle position before enforcing unlock.

### 6.8.8 “Record”

S40/S50 data information includes two kinds: the flight data and the mission data, the two of which record and downloaded separately.

Flight data automatically enables 1Hz record after takeoff.

The mission data is recorded by task triggering, so each time the mission state changes, S40 /S50 automatically execute a mission record. The data can be used as POS data for mapping and is recorded synchronously with the photographing action of camera.

**Tips: the mission data record can be used as POS data during aerial photographing and is synchronous with that of photographing action of camera.**

S40/S50 provides all the flight data, record of task data, download and replay function.

#### Record

The pop-up interface of Airborne Data Record is shown as Fig.6.8.34. Click “Start record”, S40/S50 automatically records the flight data information according to the recording frequency.

Click “Stop”, S40/S50 will automatically stop recording the flight data information.

The flight data recording frequency of S40/S50 can be selected within 1Hz - 10Hz.

The recording mode can be “Append” or “Reset”.

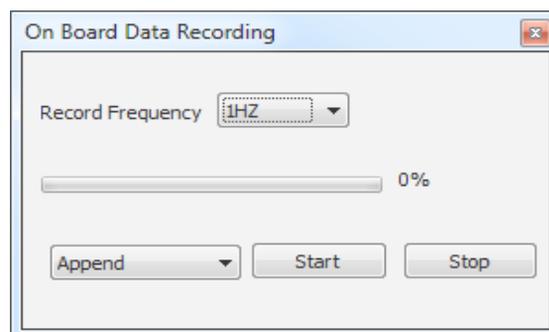


Fig. 6.8.34 Airborne data record

The airborne flight data record follows the last record by default. When the data recorded accumulates to 100%, it automatically start over from 0%, and gradually covers the original flight data information. So does the airborne mission data recording

 **Tips:** the mission data recording follows the last record by default; if it is required to record from 0, then click “Clear photographing data” when checking the mission payload prior to flight.

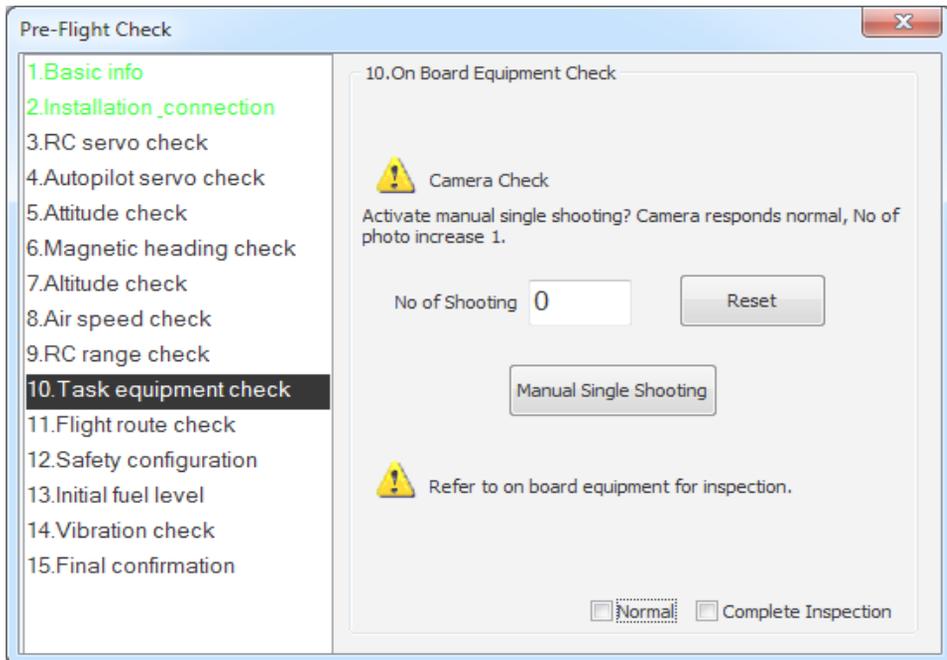


Fig. 6.8.35 Reset the number of photographing times



**Tips:** S40/S50 starts to record the flight data automatically from the non-ground segment, with 1Hz by default.



**Tips:** the “Record” menu in the function menu bar refers to the airborne record, the data information is recorded in S40/S50 (loss no information without power).

The “local data records” shortcut key in the main interface shortcut tools column refers to the local records, and the data information is recorded in the Record files folder under the installation directory in GCS40.



**Tips:** S40/S50 provides the flight record of 9 hours and 7,000 mission data records.



**Notes:** for the important data recording information in S40/S50, users shall “Download” and save the “Local data record” in time to avoid the data being covered by the new records.

## Download

The pop-up interface of the airborne data download is shown as Fig. 6.8.36.

The user can choose the data type (the flight data or mission task data) and the data range.

Click “Start Download”, S40/S50 will automatically download the flight data or mission data in the designated range according to telemetry rate in the telemetry rate setting of the “Telemetry” menu; click “Stop download”, S40/S50 will stop downloading data information.

The flight data recording frequency of S40/S50 can be chosen within 1Hz - 10Hz.

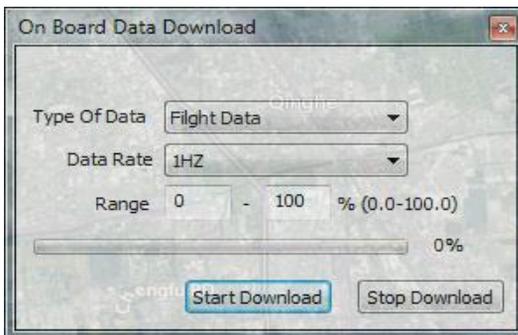


Fig. 6.8.36 Download flight data

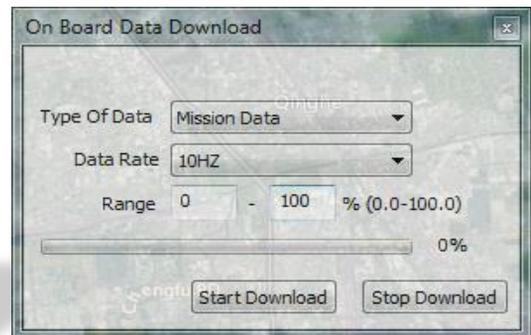


Fig. 6.8.36 Download task data (POS data)

The downloaded flight data is saved as “Record\*\*\*.csv”, and mission data downloaded is automatically saved as “Task Record\*\*\*.csv”.

**Notes:** click “Start download” when downloading the flight data, and the data information recorded in S40/S50 start to send back to GCS40.

Only when the “Local data record” shortcut key in the Shortcut tools column of GCS40 main interface is selected, the airborne data being downloaded can automatically be stored in the computer’s hard drive which GCS40 is running. Mission data downloaded is automatically saved as “Task Record\*\*\*.csv”.

**Notes:** After the mission data download (POS data) of the last flight is finished, the telemetry will automatically disconnect. At this time, the user needs to manually click “Stop download” to confirm that the download is completed.

**Tips:** select the downloading area as per the percentage for GCS40 flight data downloading. Therefore, check the current recording progress before takeoff and after landing (shown as Fig. 6.8.34). The data between the two recording progresses is the flight data recorded.

**Tips:** GCS40 mission data will be automatically saved when download. When aerial photography is applied, “Clear photographing data” during preflight check. Then the aerial photography POS data is recorded from zero and downloaded from zero. The aerial photography automatically stops after downloading the photography data (the telemetry disconnects).

**Tips:** the “Task Record\*\*\*.csv” file downloaded records the complete telemetry information upon the photographing moment, and can export more concise POS data of interest to the users.

**Tips:** the local record files in GCS40, whose format is compatible with Microsoft office, can be directly used to analyze the flight data. GCS40 can also use the record files for flight data replay.

## Playback

GCS40 can replay the local data file recorded.

The pop-up interface of the local data replay is shown as Fig.6.8.37, the top zone is the replay progress bar (can be dragged), the middle zone is the play speed (can be dragged), the left button in the bottom part is to start to “Play”, the right button is to open the recorded files to replay.

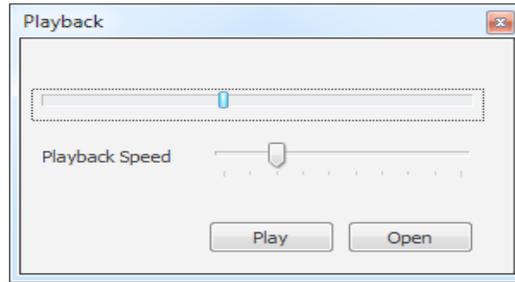


Fig.6.8.37 Local data replay

## Export POS data

The “Task Record\*\*\*.csv” file after mission data downloading records complete telemetry information upon the photographing moment, and can export more concise POS data of interest to the users.

ID	Lon	Lat	Height	Pitch	Roll	Heading	TrackAngle	Time	GPS accuracy(m)
1	0.000000	0.000000	0.0	-0.4	0.3	341.3	341.3	11:32:31	99
2	0.000000	0.000000	0.0	-0.4	0.3	341.4	341.4	11:32:32	99
3	0.000000	0.000000	0.0	-0.4	0.3	341.4	341.4	11:32:34	99
4	0.000000	0.000000	0.0	-0.4	0.3	341.4	341.4	11:32:35	99
5	0.000000	0.000000	0.0	-0.4	0.3	341.4	341.4	11:32:36	99

Fig. 6.8.38 Export POS data

### 6.8.9 “Help”

The “Help” menu includes “Color Themes”, “Help Theme”, and three functions “About GCS40”.

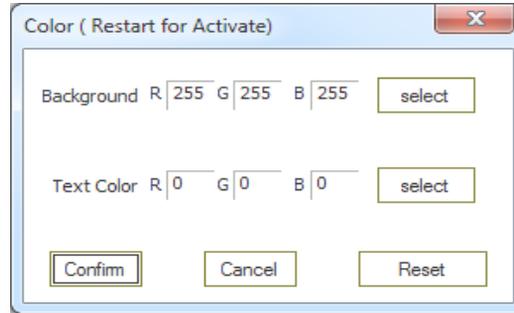


Fig.6.8.39 Color theme

### 6.8.10 “Payload”

S40/S50 supports the remote control of airborne mission payload. Remote control commands of payload can be transmitted through the flight control system transparently, to leave out the dedicated remote control link of payload.

Two common modes of remote control of payload are shown in the following diagram.

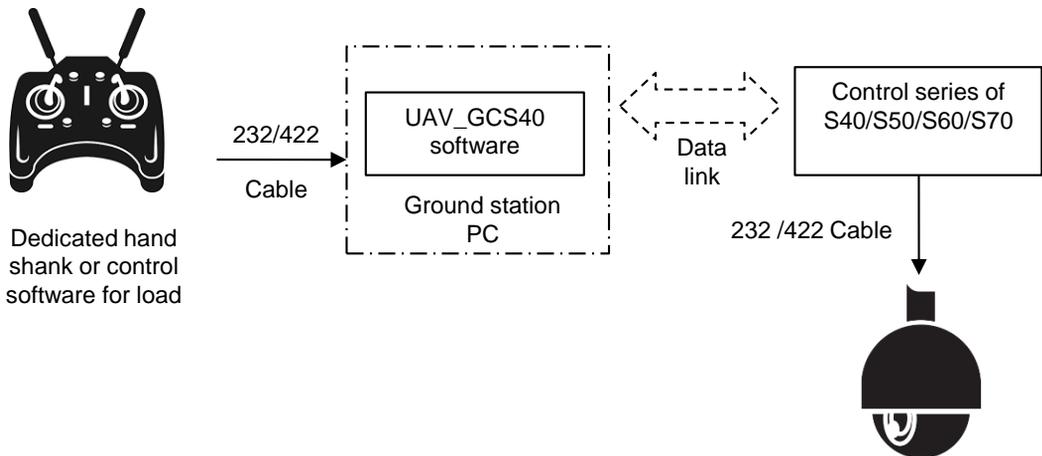


Fig. 6.8.40 Signal flow graph of load control mode 1

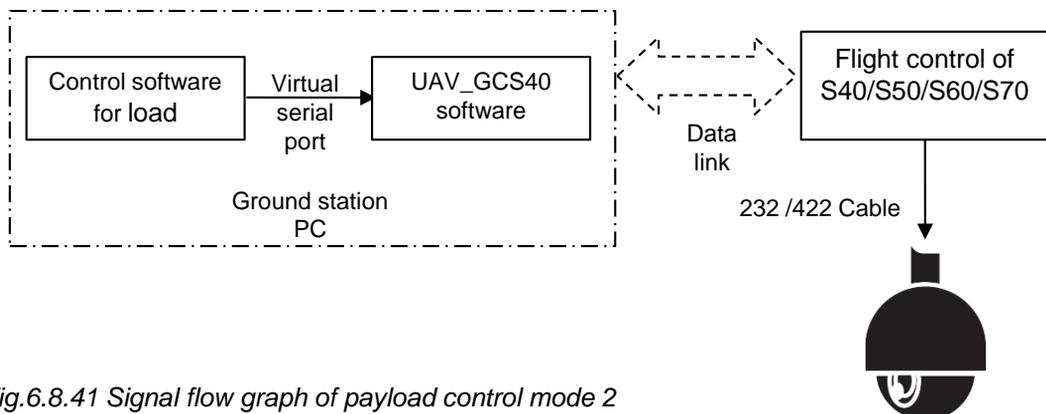


Fig.6.8.41 Signal flow graph of payload control mode 2

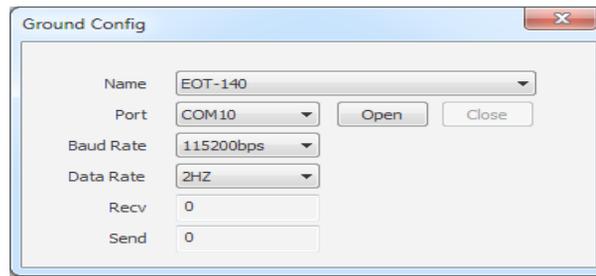


Fig. 6.8.42 Interface configuration of ground station receiving remote control commands of payload

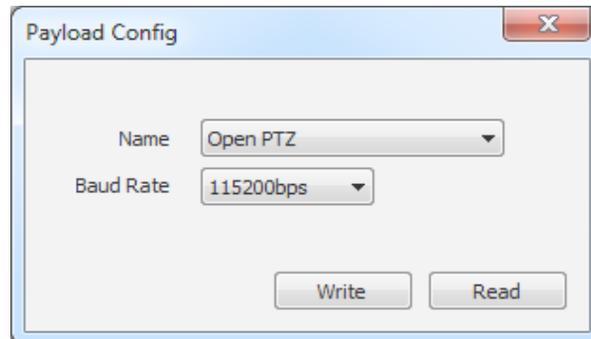


Fig. 6.8.43 Interface configuration of airborne flight control system transmitting remote control commands of payload

**Notes:** Interface configuration of ground station receiving payload remote command and airborne flight control system transmitting payload remote control commands must be consistent with the actual model and Baud rate of mission payload. Baud rate of the open cloud platform is 19200bps, and other payload needs to consult the manufacturer for confirmation.

**Notes:** On the interface configuration interface of ground station receiving remote control commands of payload, the data frequency is optional. If the mission payload requires a high timeliness of remote control command, the data frequency can be selected as "Unlimited". Proper transmitting frequency shall be selected to prevent excessive link bandwidth occupied by the remote control commands of mission payload.

## 7 Concise Operation Process

### 7.1 Hybrid UAV



**Notes:** the manually remote control flight process of hybrid UAV is as follows:

1. Use RC remote controller to switch to manual control mode and the aircraft mode switches to multi-rotor mode.
2. The aircraft takeoff in the multi-rotor mode, with attitude control in the manual mode.
3. At certain altitude, use RC remote controller to switch the aircraft mode to transition mode.
4. Now throttle control is the fixed-wing throttle, start accelerating.
5. After reaching the stalling speed, switch to the fixed-wing mode.
6. Cruise in the fixed-wing mode, with servo surface remote control in manual mode; if there is significant zero position offset, mechanical adjustment is required after landing.
7. After cruise flight, lower the altitude in the fixed-wing mode.
8. Use the RC remote controller to switch the aircraft mode to multi-rotor mode.
9. Execute landing in the multi-rotor mode, with attitude control in the manual mode; if zero position is fine adjusted during fixed-wing cruise, little counter -rudder flight is required during multi-rotor landing.

## Hybrid UAV



**Notes:** the process of full-auto flight of hybrid UAV is as the following:

1. Power up the ground station, RC remote controller and aircraft.
2. Operate according to “Preflight check” process and inspect each item.
3. Lock RC remote controller and switch to full-auto mode; place the elevator, aileron, rudder and throttle lever at zero position (the fine tuning amount of each zero position is at 0), or deactivate RC remote controller.
4. Make sure the aircraft nose is set against the wind direction.
5. Use GCS40 to send the “Takeoff” command; multi-rotor motor pre-rotates for 5 seconds, and the aircraft take off vertically and hover at 3m above.
6. Use GCS40 to send the “Cruise” command. The aircraft climb in multi-rotor mode to the “Min Relative Height+10m” altitude; if the altitude is higher than “Min Relative H”, the aircraft enters the transition stage and activates fixed-wing; gradually accelerates to the maximum throttle position, with circling route by default (rightward).
7. When the flight speed reaches the preset value, the multi-rotor motors stop and the fixed-wing accelerates with maximum throttle for 4s to initiate the aircraft enters rightward circling route.
8. If the aircraft circles for 1 round in fixed-wing mode, check whether its status is normal.
9. The target waypoint switches to the first waypoint of the designed route and the aircraft flies into the formal task route.
10. Observe the aircraft telemetry information on GCS40 and solve any abnormality in time.
11. After the flight mission is completed, generally, the target circling point is “Uploaded as landing route” to generate landing route automatically, enabling the aircraft to circle and descend, straight return, decrease airspeed, switch to multi-rotor mode in advance based on distance, and land vertically upon arrival at home, or use GCS40 to send the “Home” command. Upon arrival at “home” and descending to the altitude of “home”, the aircraft switches to the multi-rotor mode automatically, lands vertically and stops the engine automatically. If the switching mode for the last waypoint of the route is “auto landing”, the aircraft will automatically switch to the multi-rotor mode upon arrival at the last waypoint descending at the preset altitude of the waypoint, and then lands vertically, stops the engine automatically. if necessary, engine stop is done by RC remote controller or GCS40.

## Hybrid UAV

 **Notes:** if the flight control system and motor system are powered separately, then power up the flight control system first during powering up and power off the flight control system last after powering off.

Notes: if the preflight check is uncompleted or system alarm rings, the “Take off” command cannot be send

 **Notes:** after the flight control system receives the “Takeoff” command, it executes the “Take off” command only when the following conditions are met simultaneously.

1. GPS positioning is normal;
2. Full-auto control mode;
3. The system is in normal status(non-calibration, non-protection);
4. Multi-rotor mode;
5. Each lever (aileron, elevator, throttle and rudder) is at the zero position and the fine tuning amount of each zero position is at 0.

 **Notes:** the flight preparation of hybrid UAV with oil-fueled fixed-wing motor:

1. Before starting the engine, carry out “Preflight check” according to the process, until all items prior to “Vibration state check” are checked.
2. Switch to fixed wing, start the engine, warm up the engine and carry out “Vibration state check”.
3. After the “Vibration state check”, engine maintains idling speed, then lock flight control through the remote controller (under manual mode, lock the remote bar with “Outside Eight” character).
4. Under manual mode, switch to multi-motor and then full-auto mode; the oil engine will maintain idling speed automatically until the UAV is ready for taking off.

 **Notes:** precautions of electric starting of oil-powered fixed-wing engine during the flight:

- Electric starting of the engine control the starting motor through PWM signal.
- PWM9 is multiplexed by the PWM channel of electric starting of engine and the parachute opening channel, which needs to be selected through channel configuration.
- Control quantity of the electric starting of engine needs to be calibrated. Enter other servo calibrations, select PWM9 channel, with the negative limit and zero position corresponding to inactivated and the positive limit corresponding to start.
- Electric starting of the engine is not automatic, which needs ground remote control: starting command is send through RC remote controller in the manual/semi-auto mode and through UAV\_GCS40 software in the full-auto mode.
- The RC remote controller must be unlocked before sending the start command.
- The start command for engine is not implemented when Engine stop is effective.
- The start command sent by UAV\_GCS40 software will be canceled automatically after 3s of the execution. It is necessary to resend the command if the engine do not start within 3s. Send “Cancel start” command if the start command is required to exit in advance.

## 8 Common Q&A for S40/S50

**Q:** When the ground station software UAV\_GCS40 is installed and operated, the text displayed on the preflight inspection interface is dislocated.

**A:** This is caused by inappropriate character setting of the Windows operation system, the user needs to restore the system character size to the default setting.

**Q:** Installation of the ground station software UAV\_GCS40 cannot be started normally;

**A:** The user needs to reinstall net framework 3.5, net framework 4.0 is selected by default for some operating systems, which is incompatible to UAV\_GCS40.

**Q:** Control authorities of RC remote controller;

**A:** RC remote controller has the highest authority within its effective signal range. The operator can switch and take charge of the UAV at any time. In multi-rotor mode, RC remote controller can operate UAV in manual, semi-auto and full-auto modes; in fixed-wing mode, it can operate UAV in manual and semi-auto modes. Specific details are shown in 3.1 RC Remote Controller.

**Q:** During return or landing in multi-rotor mode, the UAV can not return or descend normally.

**A:** Generally, this is because elevator, aileron or throttle lever of RC remote controller is touched which lead to controlled quantity output (in multi-rotor mode, RC remote controller can operate the UAV in full-auto mode). This is the same as the operator takes over the UAV, and at this time the operator needs to place the lever of remote controller at zero position, and then the ground station re-sends return or landing command according to the situation.

 **Notes:** during return or landing in multi-rotor mode, if no abnormality, do not touch any lever or switch of the remote controller!

 **Notes:** In order to prevent the RC remote controller of the multi-rotor from malfunctioning in full-auto mode, sending “take-off”, “cruise”, “landing”, “waypoint switching” or one-key landing command will set the RC remote controller Failure of the multi-rotor in full-auto mode (backward/forward, left/right, yaw, and altitude can not be remotely controlled), unlocked by continuous action in the throttle lever -> upper -> medium -> upper -> (interval <3s). No such Failure mode for manual and semi -auto conditions.

**Q:** Touchdown and Engine stop in multi-rotor mode;

**A:** without laser range finder, longer time is required for touchdown and Engine stop in multi-rotor mode (about 3s); manual shutdown can be executed upon touchdown, to provide security.

Touchdown and shutdown can be more accurate if there is laser range finder.

